REPORT OF SURVEY

APALACHICOLA RIVER WATERSHED

For Runoff and Waterflow Retardation
and Soil Erosion Prevention

U. S. DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY REPORT

APALACHICOLA RIVER WATERSHED

ALABAMA, FLORIDA, AND GEORGIA

Program for Runoff and Waterflow Retardation and Soil Erosion Prevention

Pursuant to the Act approved June 22, 1936 (49 Stat. 1570) as amended and supplemented

January 1952

C O N T E N T S

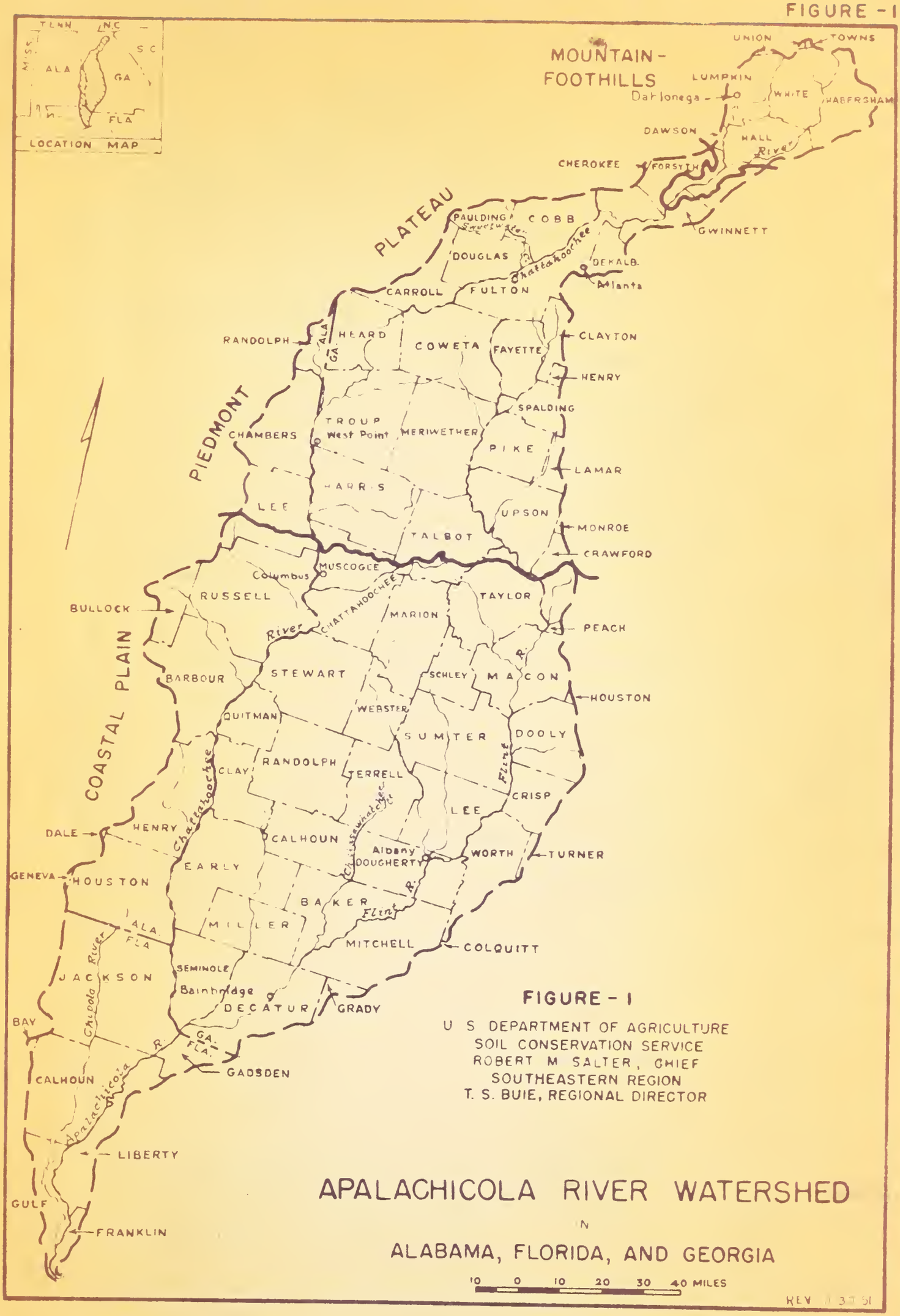


FIGURE - 1

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M SALTER, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL DIRECTOR

APALACHICOLA RIVER WATERSHED

IN

ALABAMA, FLORIDA, AND GEORGIA

REV 1 3 7 51

2-L-7661-5

INTRODUCTION

Authority

This report is submitted under the provisions of the Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented.

Purpose and Scope of Report

The purpose of this report is to outline a program of runoff and waterflow retardation and soil erosion prevention for the Apalachicola River Watershed in Georgia, Alabama, and Florida and to present recommendations for the installation and maintenance of the program, together with an analysis of the cost and benefit.

RECOMMENDATIONS

It is recommended that a program of runoff and waterflow retardation and soil erosion prevention be installed during a 15-year period in the Apalachicola River Watershed at an estimated cost of $41,864,000 to the Federal Government, and at an estimated cost of $33,253,500 or its equivalent[1/] to local interests, making an estimated total cost of $75,117,500 for the installation of the complete program.

The program will be operated and maintained at an estimated annual cost of $318,700 to the Federal Government, and $6,744,100 or its equivalent to local interests, making an estimated total annual cost of $7,062,800.

1/ Labor, materials, equipment, land, easements, rights-of-way, and other contributions in lieu of cash payments.

The recommended program has as its objectives the reduction of floodwater and sediment damage, and the conservation of soil and water resources. The interdependent measures that will accomplish these objectives are as follows: Subwatershed waterways, gully stabilization and sediment control, erosion control along roads and railroads, field diversions, terraces, perennial vegetation establishment, improvement of existing perennial cover, pasture establishment, pasture improvement, wildlife area plantings, farm waterways, improved fire protection, tree planting for watershed restoration, cover improvement on private forest land, public acquisition, development and management of lands to be acquired, stream channel improvement and streambank stabilization, floodwater retarding structures, and other soil and water conservation practices and measures.

Educational assistance, direct aids, and technical services will be provided and will be synchronized and adapted toward the specific objectives of floodwater and sediment damage reductions.

The Secretary of Agriculture may make such modifications or substitutions of the measures described in this report as may be deemed advisable due to changed physical or economic conditions or improved techniques whenever he determines that such action will be in furtherance of the objectives of the recommended program.

It is estimated that the recommended program will yield an average annual benefit of $6,671,800, due to flood damage reductions and land enhancement on flood plains. In addition to this flood-control benefit, an estimated average annual benefit of $114,827,200 from soil and water conservation, conservation farming, and forest land management will accrue to the owners and operators of farm land, timber land, railroads, highways, and lands to be acquired for watershed protection.

The ratio of the estimated average annual value of the total benefit to the average annual value of the total cost of the recommended program is 2.70 to 1[1/].

The recommended measures will be installed on non-Federal land under cooperative arrangements with State and local governments, soil conservation districts, or other agencies acceptable to the Secretary of Agriculture.

The program herein recommended includes the intensification, acceleration, and adaptation of certain activities under current programs of the Department of Agriculture, and additional measures not now regularly carried out in such programs, all of which are necessary to complete a balanced runoff and waterflow retardation and erosion control program for the watershed. It is recommended that the Secretary of Agriculture be authorized to carry out this program. The extent to which the work recommended in this program is to be carried

---

1/ Comparison of benefits and costs based on future price and cost levels assumed to prevail under an intermediate level of employment.

out under authority of the Flood Control Act as requested herein or under other authorities will be considered by the Secretary in requesting appropriations for the conduct of the recommended program. Although the current activities of the Department primarily related to the Flood Control Act are not included in the program herein specifically recommended, this program is based on the continuation of such current activities at least at their present level. The extent to which the measures in the recommended program may be carried out by an increase in the current programs of the Department will be taken into account in requests for the appropriation of funds to carry out the recommended program.

The authority of the Secretary of Agriculture to prosecute the recommended program shall be supplemental to all other authority vested in him, and nothing in this report shall be construed to limit the exercise of powers heretofore or hereafter conferred on him by law to carry out any of the measures described herein or any other measures that are similar or related to the measures described herein.

The Secretary of Agriculture may construct such buildings and other improvements as are needed to carry out the measures included in the recommended program.

DESCRIPTION OF THE WATERSHED

The Apalachicola River Watershed has a total area of 19,730 square miles, of which 75 percent is in Georgia, 15 percent in Alabama, and 10 percent in Florida.

The Apalachicola River proper is formed by the confluence of its two major tributaries, the Chattahoochee and Flint Rivers, near the Georgia-Florida state line (figure 1). These two principal tributaries have a watershed of 8,903 and 8,742 square miles, respectively. The Chattahoochee River rises on the southern slopes of the Blue Ridge Mountains in northeastern Georgia. The Flint River rises in the Piedmont Plateau near Atlanta, Georgia. The Apalachicola River discharges into Apalachicola Bay in the Gulf of Mexico at Apalachicola, Florida.

For the purpose of this report the watershed is divided into three major subdivisions (see figure 1).

1. The Mountain-Foothills area comprises about 5 percent of the watershed. The area has a rugged topography, broken by broad interstream divides and nearly level flood plains. The steep areas are predominantly wooded, have narrow valleys and high stream gradients.
2. The Piedmont Plateau area comprises about 30 percent of the watershed. It is the most highly developed agricultural section of the watershed and contains large urban and industrial centers. Sheet and gully erosion are severe and runoff is relatively rapid.
3. The Coastal Plain area comprises about 65 percent of the watershed. It is flat to gently rolling in topography except along the Fall Zone which is steeply rolling. Flood plains are wide and well developed and stream gradients are low.

Approximately 55 percent of the watershed is in forest, 25 percent cultivation, 5 percent pasture, 9 percent idle land, and 6 percent miscellaneous uses. Most of the forest land is in poor to mediocre condition in terms of runoff and soil stability because of fire, grazing, overcutting, improperly maintained roadways, and destructive logging. Much of the open land is seriously eroded, and pastures are commonly unimproved, trampled, and overgrazed. For the watershed as a whole, a relatively small acreage of the bottom land subject to flood overflow is now used for agricultural purposes. However, a much larger area has been so used at various times in the past, but is not cultivated now because of deposition of infertile sediment, scour damage, swamping, and increased flood hazard.

The average annual precipitation ranges from 50 inches in the Piedmont Plateau area to 61 inches at Dahlonega, Georgia, in the Mountain-Foothills area. An average of 51 inches occurs in the Coastal Plain area.

The population of the watershed in 1950 was approximately 1,356,000, of which about 54 percent lived in rural areas. In 1945, farm tenancy ranged from about 35 percent in the Mountain-Foothills area to about 63 percent in the Coastal Plain area.

Agriculture is the principal enterprise in the watershed. Peanuts, cotton, truck crops, and orchard crops are the main cash crops. Timber products are manufactured in considerable quantity. The principal industries are textile mills, forest product mills, cotton and peanut processing plants, canning plants, fertilizer plants, and gas and electric power plants.

The watershed is served by excellent transportation systems of airlines, highways, and railroads. Many of the roads are located in the valleys adjacent to the streams and are subject to the damaging effects of floods.

FLOOD PROBLEMS

The size of the area, physiographic variations, and storm characteristics are such that storms have rarely produced floods simultaneously in all parts of the Apalachicola River Watershed. Major floods in the basin are most common during the late winter and early spring months. The summer floods are usually due to storms of the tropical hurricane type, with intense rainfall. The winter and spring floods are normally due to storms with sustained rainfall of less intensity.

The greatest flood of record on the Chattahoochee River at West Point, Georgia, was in December 1919. The highest flood of record on the Flint River at Albany and Bainbridge, Georgia, was in January 1925. The greatest flood of record on the Apalachicola River in Florida occurred in March 1929. It was due to the synchronization of flood waters from a storm which extended over the lower portions of both the Chattahoochee and Flint River Watersheds.

Violent local storms in the mountain areas create flash floods, the force of which is dissipated before the flood flows progress very far downstream. However, those floods cause local damages to stream banks and channels and to the adjoining bottom lands. Also, prolonged rains in the Piedmont Plateau area

cause overflows of longer duration on tributary streams, but these flows are often absorbed by the main stream without any appreciable rise in stage.

Land damage and destruction of growing crops are the largest items of flood damage in the watershed. A high percent of all agricultural damages occurs on the bottom lands of the small tributary streams.

West Point, Georgia, suffers the greatest urban and industrial damages of any urban center in the watershed. Columbus, Georgia, is the largest town in the watershed suffering significant damages. Serious damage to highways and railroads occurs mainly during major floods.

Other damages which were considered but not evaluated in monetary terms in this report include loss of life, illness caused by floods, personal injuries, insecurity of property and income, disruption of public services and education, and costs of relief and emergency sanitation. The prevalence of these hazards, however, furnishes additional incentive for the program recommended in this report.

The highest rates of runoff occur on the unimproved, trampled, overgrazed pastures, idle lands, and other steep uplands including forest lands which are grazed, heavily overcut, and repeatedly burned. At present approximately 73 percent of the forest land area is classed as poor from the standpoint of runoff retardation.

The most critical runoff and sediment source areas are the more seriously eroded portions of the Piedmont Plateau and Mountain-Foothills area. Gullies are the most serious source of the coarser grained sediments. It is estimated that in the entire watershed there are 18,684 miles of active gullies. About 57 percent of the active gullying occurs in the Piedmont Plateau, but the largest and most rapidly eroding gullies are in the Upper Coastal Plain area.

Unprotected drainageways and cut and fill slopes are another important source of runoff and sediment. Much of the material which is eroded from unprotected cut and fill slopes along roads and railroads is transported directly to the stream channels or is deposited on productive agricultural land.

Swamping is the principal sedimentation damage. In the Piedmont Plateau portion of the watershed almost half of the total flood plain has been damaged by impaired drainage. Deposits of sand and scouring away of the flood plain surface during floods have caused widespread, though less severe, damages.

Streambank erosion is of occasional occurrence although extensive damage takes place only during major floods. Most stream banks are heavily vegetated.

Sedimentation is damaging the retention type reservoirs, many of which are already filled or are rapidly filling with sediment.

The cost of treating public and industrial water supply depends to a considerable extent on the amount of suspended material carried by the water to be treated. Turbidities

are greatly increased during flood periods, adding to the cost of water treatment.

Sediment damages to navigation and drainage channels, public health, crops, property, and recreational values have been recognized but were not evaluated in monetary terms in this report.

The estimated average annual monetary damages in the Apalachicola River Watershed are distributed as follows: Floodwater damage to agriculture (crops, pasture, and fixed improvements), 42 percent; reservoir sedimentation damage, 9 percent; water treatment, 9 percent; land damage including sanding, swamping, and scour, 25 percent; and damage to roads and railroads, 15 percent.

Table 1 lists the estimated average annual monetary damages in the Apalachicola River Watershed. Those prevented by current or authorized programs of public agencies are not included.

Table 1. Estimated Average Annual Monetary Damages in the Apalachicola River Watershed

Type of Damage	Average Annual Damage (1949 Prices) (dollars)	
Floodwater Damages		
Agricultural - Crop, Pasture, and Fixed Improvements	416,800	
Non-agricultural - Roads and Railroads	152,300	
Subtotal		569,100
Sediment and Land Damages		
Reservoir Sedimentation	85,500	
Water Treatment	92,500	
Land Damage (Sanding, Swamping, and Scour)	242,700	
Subtotal		420,700
Total Average Annual Damage		989,800

ACTIVITIES RELATED TO FLOOD CONTROL

The Department of the Army, Corps of Engineers, has developed a comprehensive plan of improvement for the Apalachicola River basin, consisting of 11 developments for hydroelectric power, flood control, navigation, and other uses. This plan described in House Document 342, Seventy-sixth Congress, was modified by House Document 300, Eightieth Congress. Two developments, the Buford project on the Chattahoochee River and the Jim Woodruff project on the Apalachicola River, are now under construction.

The Department of Agriculture, through its various agencies, is actively cooperating with State and local agencies in carrying out programs for the conservation of soil, water, and timber resources. State forestry agencies, in cooperation with the Forest Service, protect private forest lands against fire, provide technical assistance to owners in the proper management of their forest lands, and make trees available for reforesting open and poorly stocked forest land. The Production and Marketing Administration offers financial assistance to farmers for carrying out soil and water conservation practices. The Department also cooperates with State Extension Services and Experiment Stations in educational and research work in the conservation of soil and water resources. The Soil Conservation Service is currently assisting landowners and operators in the application of soil and water conservation measures on farm lands. The present annual Federal cost of those portions of the Department's "going" programs which produce flood control and associated benefits is approximately $2,936,800.

The Forest Service administers and protects approximately 216,000 acres of national forest land which was acquired for watershed protection and for timber production.

The Department of Interior through the U. S. Geological Survey, Surface Water and Ground Water Divisions maintains and operates gaging and measuring stations, and investigates ground water problems, throughout the watershed in cooperation with state governments and other Federal agencies. Published data thus acquired and data obtained under cooperative agreements are the main sources of stream and ground water information available.

The Fish and Wildlife Service and State fish and game conservation agencies are actively engaged in programs of fish and wildlife habitat improvement.

Soil conservation districts, organized under State laws, cover all counties wholly or partially within the watershed except two in Florida and two in Georgia. These districts are actively engaged in a program of soil and water conservation and land management on farm lands, with technical assistance from the Soil Conservation Service, and with the cooperation of other Federal, State, and local agencies.

Although the primary purpose of the conservation programs in the area has been the maintenance of soil resources and improvement of crop and timber yields, and fish and wildlife resources, they have produced some flood control benefits.

The States of Georgia, Alabama, and Florida have done a limited amount of erosion control work along the principal highways.

RECOMMENDED PROGRAM

The program of runoff and waterflow retardation and soil erosion prevention recommended in this report was developed from a study of representative sample areas. The present condition of sample areas and minor watercourses was considered in detail to determine the types and quantities of practices and measures that would be most effective in reducing floodwater and sediment damages. The data derived by the sampling procedure were applied to relatively similar areas to estimate total requirements of the most beneficial and practical works of improvement for runoff and waterflow retardation and soil erosion prevention.

The recommended program will accomplish a substantial decrease in floodwater and sediment damage and an increase in the productivity of watershed lands. Practices and measures will be installed primarily for retarding or controlling water from the time it reaches the land until the excess flows are discharged into the major streams. Some measures will be installed to increase the absorptive capacities of the soils, while others will be installed to conduct runoff that cannot be absorbed by the soils along the least damaging route to the major streams. Additional measures will be used to trap or screen out sediment that is not otherwise controlled. All of these measures installed in the proper combination and sequence will be necessary to provide for the most practical and effective utilization of rainfall and orderly management of runoff. Since the program of recommended

measures was developed to function as a whole, each integral measure will be designed to function most effectively in combination with the others. The income of farm and forest land owners and operators is expected to increase materially as the recommended program becomes progressively effective. No major changes in the production of cash crops are involved, and it is anticipated that the principal cash crops will continue to be peanuts, cotton, truck crops, and orchard crops. The greatest increases in acreage will be in pasture, perennial hay crops, and forest land.

The program will be carried out during a period of 15 years. Works of improvement will be installed, operated, and maintained largely by the landowners, operators, and other local interests. The scheduling of Federal participation will be dependent upon the rate at which local cooperation develops. The quantities of measures shown in table 2 are based on total watershed needs less the estimated accomplishments under "going" programs of the Department over a 15-year period.

The recommended program consists of the following interrelated and interdependent measures:

Subwatershed Waterways.--Uncontrolled runoff from individual farms and groups of farms is producing excessive bank cutting and scour in secondary channels. In addition, serious damage results to bottom lands by deposition of harmful sediments. Reshaping of waterways to obtain broad watercourses of adequate capacity

with low velocities of flow, as well as the application or installation of protective vegetation and structural controls for stabilization, will be provided to reduce this flood and sediment damage. Where necessary, waterways will be extended across flood plains to dispose of surplus water.

A small amount of floodwater storage will be provided for in some of the structures used in the water disposal systems for subwatersheds in order to reduce the installation cost of other measures in the systems and to provide protection to flood plain lands and improvements.

Gully Stabilization and Sediment Control.--Gullies are one of the principal sources of sediment. They extend up the slopes and expand into a gully system which progressively increases in depth, size, and area of destructiveness. Concentration of runoff in the gully channels creates sluiceways for the transport of erosional debris to lower streams and valley lands. Active gullies in open land and forest land are large contributors to the deposition damage problem. Gully treatment emphasizing vegetative stabilization with trees and perennials such as kudzu, Lespedeza sericea, and local shrubs will be provided. Other types of controls including gully control dams and other structural means will be utilized. Drainage from overlying areas will be

diverted from the gullies into stabilized waterways. The gully stabilization work will be designed to decrease the volume of sediment originating in active gullies, reduce the rate at which land is being destroyed by gullies, and retard the present rapid concentration of runoff. At the mouth of some of these large gullies, or at a point of concentration of a sediment producing area, temporary earth dams for sediment control will be constructed. These structures will be supplemented with plantings of deep-rooted shrubby perennials or trees which will provide effective protection throughout the year over a long period of time. Temporary dikes and diversion ditches will be used to afford protection until the vegetative plantings are established.

Erosion Control Along Roads and Railroads.--Unprotected slopes of earth excavation and embankments for roads and railroads and along outfall ditches are major silt producing sources. In many cases, adequate water disposal measures have not been adopted and installed, and terraces often discharge directly down steep slopes of road cuts and into road ditches. These conditions are conducive to extensive erosion, and large volumes of sand and silt are washed downstream to fill stream channels and to spread over fertile bottom lands.

Vegetative plantings and mechanical measures will be provided for more orderly control and disposal of storm runoff and reduction of the volume of sediment originating along road and railroad rights-of-way.

Field Diversions.--Diversion channels will be installed on slopes too steep for terraces and where orderly discharge of surface runoff is necessary for the protection of lands lying immediately below.

Terraces.--Terraces will be installed to manage the runoff from sloping lands, principally those in cultivation, and to reduce soil erosion and sediment damage. They will direct the surface runoff not otherwise disposed of into water-disposal systems.

Perennial Vegetation Establishment.--Deep-rooted perennial grasses and legumes will be established on critical areas, needing heavy vegetative cover, to retard runoff and erosion. These perennials will provide desirable forage for livestock.

Perennial Vegetation Improvement.--Perennial vegetation, already planted but providing inadequate ground cover, will be improved by fertilizing, liming, overseeding with other grasses or legumes, fencing for controlled grazing, and other renovating measures necessary to attain a desirable hydrologic condition.

Pasture Establishment.--Suitable areas, from a land capability standpoint, will be planted to adapted grasses and legumes for permanent pasture.

Treatment will include clearing, land preparation, liming, fertilizing, seeding, fencing, and other measures necessary to establish and maintain good ground cover. This acreage, adequately covered, will reduce runoff and sediment damages and provide an increase in pasturage.

Pasture Improvement.--Old pasture lands will need additional treatment such as fertilizing, liming, seeding, and other renovating measures in order to improve the hydrologic condition and increase grazing to a desirable level.

Wildlife Area Plantings.--Small, irregular, and inaccessible areas, as well as narrow strips of land along field borders often left idle, are sources of serious erosional debris and present runoff problems. This condition will be corrected by planting such areas to adapted plants that will control erosion and produce food and cover for wildlife. Fences will be constructed where necessary to protect these areas from grazing.

Farm Waterways.--Natural and artificial farm waterways have been severely damaged by gullying, and in many cases where protective measures have been applied, they have not been properly installed and maintained. The improvement of existing drainageways and the installation of new waterways will be provided to permit the safe

disposal of excess water from farms. Farm waterway improvements will consist of vegetated drainageways such as broad type meadow strips, V-shaped vegetated channels, and grassed or sodded terrace outlets. Supporting structures will be installed to implement vegetative control. Waterways on individual farms will be planned and installed in accordance with natural drainage of adjacent farms so that the waterways will function as a unit. The stabilized farm waterways and outlets will reduce sediment and land destruction resulting from uncontrolled runoff.

Forest Fire Protection.--Improved fire protection will be provided for all forest land except national forests[1/]. This includes intensified protection for private forest land and lands to be publicly acquired. Fire protection is a key measure both for the reduction of runoff and erosion and for accomplishing all phases of the recommended forestry program.

Tree Planting for Watershed Restoration.--Trees will be planted on depleted open and idle lands and sparsely stocked forest land, including areas to be shifted into public ownership. This will restore a protective cover on lands which are prime sources of damaging runoff and sediment. Tree planting is the quickest and most effective means of developing good hydrologic conditions.

1/ Present national forest lands are adequately protected.

Cover Improvement, Private Forest Land.--Watershed cover will be improved on private forest lands through an expanded program of technical services, provided at public expense, to forest owners and operators. The services will include advice and guidance in planning and applying forest measures, in harvesting and marketing timber products, and in helping minimize logging damage to soils and other values. The basic aim is to improve density and quality of watershed cover by putting the lands under good sustained yield management.

Public Acquisition.--The Federal Government will acquire an area of mountain and foothill land within and immediately adjacent to the Chattahoochee National Forest in the headwaters portion of the watershed. The land to be acquired is in poor condition as a result of destructive cutting, fire, and other factors. Private incentive to properly manage these separate tracts is lacking because of the low economic returns and the long waiting involved in putting them in productive condition. They will be acquired only through voluntary sales by the owners and in accordance with such enabling agreements with State and local governments as may be required by law. These lands will be administered as a part of the Chattahoochee National Forest.

Development and Management of Lands to be Acquired.--This provides for rehabilitation and management of the lands to be acquired so as to build up cover and provide watershed protection as well as increasing timber and other resources. Included are physical improvements, and personnel and other facilities for the continuing resource management activities which will contribute to cover improvement.

Stream Channel Improvement and Streambank Stabilization.--This measure, consisting of clearing and removing debris, enlarging and straightening channels, and establishing suppressive and protective vegetation on the banks of streams, will be installed to regulate the movement of floodwater, provide an immediate reduction in flood stages along tributary channels, and permit a more productive use of fertile flood plain land.

Floodwater Retarding Structures.--In order to reduce the frequency and severity of flooding of good agricultural lands, upstream floodwater retarding structures will be installed. A majority of these structures will be within the Piedmont Plateau Physical Land Unit.

The usual structure will be a dam with rolled-earth fill, providing temporary storage of at least three inches of flood runoff. Each structure will be fitted with an automatic drawdown conduit for the purpose of discharging flood storage at a rate less than the capacity of the stream channel below dam.

In addition, conservation storage will be provided for a sediment reserve, livestock water supply, wildlife, and recreational uses.

Testing the Effectiveness of the Program.--Measurements will be made on a number of selected subwatersheds in areas where runoff conditions are highly critical to determine the quantitative effects of the planned watershed improvement program. Such measurements will permit an evaluation over a period of years of the combined effectiveness of the various measures installed and maintained. The data will also provide a technical and economic guide for installing the rest of the program.

Additional soil and water conservation practices and measures will be applied to obtain a proper combination with the mutually supporting measures listed above and to complete a basic system of soil and water conservation and proper land use in accordance with the needs and capabilities of the land of the watershed. This will include other farm and forest land practices and measures to make more effective or facilitate the installation of the above measures. This will produce a practical and workable combination of measures that will be efficient in providing runoff and waterflow retardation and soil erosion prevention.

Landowners and operators and others in the watershed will be furnished educational assistance relative to the need for

the recommended program and its purposes and objectives. Information will be supplied as to the manner in which landowners and operators now obtain services and assistance that are available through the various governmental agencies and how they can and should by their own efforts contribute successfully and most economically to the accomplishment of the over-all objectives. Intensified educational efforts will be directed toward familiarizing farmers with the specific practices essential to waterflow retardation and soil erosion prevention; and how to install and apply those measures not requiring the detailed assistance of a specialized technician, how to maintain such installation and measures, and how to integrate all into the soundest farming system to produce the greatest benefit over a long period of time.

The Department of Agriculture is committed to a watershed and subwatershed approach in carrying out its responsibilities under the Flood Control Acts. It is essential that educational assistance provided under the recommended program be directed toward furthering the specific objectives of floodwater and sediment damage reduction and that it be fitted as to method and synchronization into subwatershed operations activities.

Technical services will be provided for (1) planning and applying forest land improvement measures and management practices for watershed protection, (2) growing, harvesting, utilizing, and marketing timber crops, (3) planning and applying land use adjustments, (4) planning and applying conservation measures on the farm, and (5) integrating the installation of individual measures into a proper combination to achieve the

most effective program of runoff and waterflow retardation and soil erosion prevention. These services will be supplied to assist the people in the watershed in installing the recommended measures on their land and in adopting the recommended practices for their farm and forest land operations.

COST OF THE RECOMMENDED PROGRAM

The estimated cost of installing the recommended program in the Apalachicola River Watershed is approximately $75,117,500. Of this amount, it is estimated that the Federal Government will expend $41,864,000; non-Federal public agencies, $2,291,200; and private interests, $30,962,300. The estimate of total costs and the apportionment of costs to the Federal Government, non-Federal public agencies, and private landowners and operators are based on experiences in the application of practices and measures similar to those recommended in this report.

Federal participation will include educational assistance, technical services, materials, planting stock, special equipment, and other direct aids where appropriate and needed to assist in the installation and maintenance of the recommended practices and measures.

The cost and the responsibility for the installation of any phase of the recommended program that is assigned in this report to the Federal Government may be assumed by state or local governments or responsible local agencies. It is recognized that the estimated Federal cost may be reduced as a result of a greater realization upon the part of the landowners of the advantages of installing the recommended practices and measures. State and

local agencies will be urged to participate in the program to the fullest extent possible so that they will bear a proportionate share of the cost commensurate with the benefits that will accrue to them.

The estimated average annual cost of operating and maintaining the recommended program is approximately $7,062,800. Of this cost, the Federal Government will expend $318,700; non-Federal public agencies, $1,297,900; and private interests, $5,446,200. The Federal Government will provide (1) any maintenance of measures installed by it that may be required from the time of completion of such measures to the time of their transfer in good condition to the operating and maintaining agency, (2) operation and maintenance of measures installed on Federal land, (3) up to one-half of the cost of installing and maintaining adequate fire control on non-Federal forest land, and (4) one-half the cost of technical services necessary for maintenance of forest land improvement and management practices on private forest land.

The estimated cost of installing the recommended program in the Apalachicola River Watershed is shown in table 2. This cost includes the cost of technical services, educational assistance, testing and evaluation of measures, and administration of direct aids amounting to $10,100,300, or approximately 13 percent of the total cost. Of this amount, $9,805,800 is Federal cost, and $294,500 is non-Federal public cost. Non-Federal public agencies will bear at least one-half of the cost of technical services for cover improvement and fire control on private forest land and at least one-half the cost of educational assistance.

Table 2. Estimated Cost of Installing the Recommended Program in the Apalachicola River Watershed

Item	Unit	Approximate Quantity	Cost (1949 prices)
			(dollars)
Subwatershed Waterways	Mile	3,420	1,430,400
Gully Stabilization and Sediment Control	Mile	18,684	5,042,500
Erosion Control Along Roads and Railroads	Mile	13,324	2,801,300
Field Diversions	Mile	19,390	3,660,800
Terraces	Mile	132,820	11,846,000
Perennial Vegetation Establishment	Acre	209,020	6,705,900
Perennial Vegetation Improvement	Acre	111,720	1,200,500
Pasture Establishment	Acre	104,920	5,945,600
Pasture Improvement	Acre	133,680	4,088,900
Wildlife Area Plantings	Acre	11,460	371,600
Farm Waterways	Acre	63,780	2,744,700
Forest Fire Protection	Acre	6,652,660	780,200
Tree Planting for Watershed Restoration	Acre	191,630	3,635,700
Cover Improvement on Private Forest Land	Acre	3,027,670	567,900
Public Acquisition	Acre	51,250	823,200
Development and Management of Lands to be Acquired	Acre	51,250	10,300
Stream Channel Improvement and Streambank Stabilization	Mile	6,352	12,515,000
Floodwater Retarding Structures	Number	1,500	10,947,000
Total			75,117,500

BENEFITS FROM THE RECOMMENDED PROGRAM

The principal benefits that will result from carrying out the recommended program are reductions in floodwater damage, reductions in sediment and land damages, increased productivity of bottom lands, and associated benefits such as open land conservation benefits, forest land benefits, and decreased maintenance costs on roads and railroads (table 3).

Benefits from Reductions in Floodwater Damage

The effect of the recommended practices and measures will be to reduce significantly many small floods which, considered collectively, inundate relatively large areas frequently. The medium sized floods will be modified considerably thereby further decreasing the extent and frequency of flooding. The benefit resulting from reducing floodwater damage to agriculture makes up about 4 percent of the estimated total average annual flood control benefit and most of it will accrue along the tributary streams. Benefits will also accrue to industrial, commercial, residential, utility, highway, and railroad properties. The recommended program, when installed in proper combination and sequence and adequately maintained, will reduce all floodwater damages by an estimated 48 percent.

Benefits from Reductions in Sediment and Land Damages

Benefits resulting from the reduction of sediment and related damages are of three principal kinds: reduction in reservoir sedimentation, reduction in water treatment costs, and reduction in land damages.

Benefits accruing from reducing the rate of storage loss and the consequent increase in the useful life of reservoirs were evaluated for all important reservoirs. Bartletts Ferry Reservoir was the only structure appreciably benefited by the recommended program. Most of the other dams are channel type structures built primarily for head.

Most of the water supply for public and industrial use comes from surface sources and is treated before use. The recommended program will reduce the sediment content of the water and thereby will decrease filtering and other costs of water treatment.

Sediment and related damages to land are classified as deposition of infertile materials, swamping, and scouring or washing away of the flood plain surface. These damages will be reduced by the soil and water conservation practices on the land, and by channel improvement and stabilization works which will cut down the movement and deposition of sand, improve drainage conditions by lowering the water table in swampy areas, and reduce scour by reducing the frequency of overbank flows.

The recommended program will reduce land damages caused by sanding, swamping, and scour by an estimated 80 percent.

Benefits accruing from all reductions of sediment and related damages described above are estimated to be about 4 percent of the total average annual flood control benefit.

Benefits from Increased Productivity of Bottom Lands

The recommended channel measures and associated works of improvement for controlling runoff will not only prevent swamping and reduce flood damages but will also permit the drainage of

fertile bottom lands by landowners and operators. Much of this land has a high capability for producing excellent yields of cultivated crops. Lands of lower capability when properly protected against floods and drained will produce moderate returns from hay and pasture. Approximately 380,330 acres of bottom land will be benefited from the recommended program. Benefits from land enhancement account for 92 percent of all flood control benefits in the Apalachicola River Watershed.

Associated Benefits

Other benefits evaluated in this report that will accrue from the installation of the recommended practices and measures include open land conservation benefits, forest land benefits, decreased maintenance costs on roads and railroads, and water conservation benefits.

The open land conservation benefits evaluated in monetary terms consist of the direct benefits that will accrue to participating landowners and operators through increases in farm income.

The forest land benefits were derived from a determination of yields with and without the recommended program. It is expected that under proper management the forest stands will be brought into full stocking. This will be accomplished by planting trees, providing adequate fire control, restricting the periodic cut to a portion of the annual growth until the stand is fully stocked, and other watershed forest land management practices. Comparative incomes on the basis of future conditions with and without the recommended program and expressed in present worth values were used to estimate the average annual benefits from forest land measures.

Eroded material washed down from unprotected roadway and railroad cuts and fills obstructs ditches and culverts. About one-third of the total cost of roadway maintenance is chargeable to the removal of this material. Eventually some of this eroded material causes damage to flood plains and reservoirs. Highway maintenance figures from areas already treated indicate that roadway treatment to stabilize cuts and fills and roadway ditches reduces maintenance costs by approximately 56 percent. The cost of maintenance operations along railroad rights-of-way also will be substantially reduced by stabilization measures for orderly disposal of storm runoff and control of erosion.

The water conservation benefits evaluated in monetary terms are made up primarily of the benefits expected from the permanent pools constructed as integral parts of the floodwater retarding structures. These benefits are based on an evaluation of the pools for fish production and recreation.

The full attainment of the benefits evaluated in this report is dependent upon the cooperation and support of farm and forest owners and operators and local governments in installing and properly maintaining the recommended practices and measures.

Comparison of Benefits and Costs

Based on prices and costs expected to prevail under intermediate employment levels during the period 1955 to 1965, the ratio of the average annual benefit to the average annual cost of the recommended program is 2.70 to 1.

Table 3. Estimated Average Annual Monetary Benefit from the Recommended Program for the Apalachicola River Watershed

Source	Average Annual Benefit (1949 Prices)	
	(dollars)	
Reductions in Floodwater Damage		
Agricultural - Crop and Pasture	244,100	
Non-agricultural - Roads and Railroads	28,000	
Subtotal		272,100
Reductions in Sediment and Land Damages		
Reservoir Sedimentation	32,200	
Water Treatment	18,900	
Land Damage (Sanding, Swamping, and Scour)	194,300	
Subtotal		245,400
Increased Productivity of Bottom Land	6,154,300	6,154,300
Total Average Annual Flood Control Benefit		6,671,800
Associated Benefits		
Open Land Conservation Benefit	96,149,000	
Forest Land Benefit	16,355,800	
Decreased Maintenance Costs on Roads and Railroads	1,104,000	
Water Conservation	1,218,400	
Subtotal		114,827,200
Total Average Annual Benefit		121,499,000 1/

1/ In addition to this benefit, other unevaluated benefits will accrue. The most important benefits of this type are the prevention of loss of life, prevention of interruptions in transportation and communications, improvement of wildlife habitat, preservation of aesthetic values, and improvement of the economic and social structure of the watershed area.

APPENDIXES

A, B, C, and D

SURVEY REPORT

APALACHICOLA RIVER WATERSHED

GEORGIA, ALABAMA, AND FLORIDA

C O N T E N T S

APPENDIX A

PRESENT PHYSICAL, SOCIAL, LEGISLATIVE, AND ECONOMIC FACTORS

Tables

Figures

APPENDIX B

PLAN OF IMPROVEMENT

Tables

Figures

APPENDIX C

HYDROLOGY

Tables

Figures

APPENDIX D

DAMAGES, BENEFITS, AND COSTS

Page

Tables

No.

No.

APPENDIX A

PRESENT PHYSICAL, SOCIAL, LEGISLATIVE, AND ECONOMIC FACTORS

GENERAL DESCRIPTION OF WATERSHED

Area and Population

The Apalachicola River Watershed (figure A-1) is 19,730 square miles (12,627,200 acres) in extent, affecting 78 counties, 60 of which are in Georgia, 11 in Alabama, and 7 in Florida. Twenty-eight (28) Georgia counties lie entirely within the watershed. On an areal basis 9,408,940 acres (75 percent) of the watershed lie in Georgia, 1,900,860 acres (15 percent) in Alabama, and 1,317,400 acres (10 percent) in Florida. The watershed includes the drainage area of the Apalachicola River and all of its tributary streams. The Apalachicola River proper is formed by the confluence of its two major tributaries, the Chattahoochee and Flint Rivers, near the Georgia-Florida state line.

The Chattahoochee River, above its confluence with the Flint River, has a watershed area of 8,903 square miles (5,697,920 acres). The headwater area, in northeastern Georgia, is on the southern slopes of the Blue Ridge Mountains. The Chattahoochee River flows southeastward from its source for 25 miles to its junction with the Soque River. Below this junction the river turns southwestward to flow through the foothills and across the Piedmont Plateau for a distance of 210 miles to West Point, Georgia. Here the river turns southward and flows in that direction for 40 miles to the fall zone. At columbus, Georgia, the Chattahoochee enters the Coastal Plain and flows southward 160 river miles to its confluence with the Flint River.

The Flint River Watershed has an area of 8,742 square miles (5,594,880 acres). Its source is in the Piedmont Plateau near the Atlanta Municipal Airport. It flows across the Piedmont Plateau along southerly and southeasterly courses for a distance of about 105 miles above the fall zone. From there it flows southward across the Coastal Plain for about 100 miles and then turns southwestward to flow for 130 miles to its confluence with the Chattahoochee River.

The Apalachicola River proper has a stream length of 112.8 miles. The surface elevation of the Apalachicola River at its head, at the confluence of the Chattahoochee and Flint Rivers, is 45 feet above sea level. Its chief tributary below the head is the Chipola River. The main stream discharges into Apalachicola Bay in the Gulf of Mexico at Apalachicola, Florida. The lower 25 miles of the river are tidal.

The total population of the watershed at the time of the 1950 census was approximately 1,356,000 people. Of this number approximately 1,139,000 reside in Georgia, 158,000 in Alabama, and 59,000 in Florida. On a proportionate basis, Georgia has 75 percent of the watershed area and 84 percent of the population, Alabama 15 percent of the area and 12 percent of the population, and Florida 10 percent of the area and 4 percent of the population.

In 1950 approximately 54 percent of the Apalachicola River Watershed population was rural in character. A study of the 1945 Census of Agriculture indicates that 370,000 people in the watershed lived on farms at the beginning of 1945. There has been a 12 percent increase in watershed population since 1940. In the meantime, the relation between rural and urban populations in the watershed changed from 40 percent urban in 1940 to 46 percent urban in 1950.

The largest urban center in the Apalachicola River Watershed is Atlanta, Georgia, with a population of approximately 327,000 in 1950. Second largest is Columbus, Georgia, the population of which was nearly 80,000 in 1950. Other cities within the watershed with populations of 10,000 or more in 1950, in order of size, are as follows: Albany, Georgia, 31,000; LaGrange, Georgia, 25,000; Phenix City, Alabama, 23,000; East Point, Georgia, 22,000; Dothan, Alabama, 22,000; Marietta, Georgia, 21,000; College Park, Georgia, 14,000; Griffin, Georgia, 14,000; Opelika, Alabama, 12,000; Gainesville, Georgia , 12,000; Americus, Georgia, 11,000. There are 40 urban centers in the watershed having populations of 2,500 or more in 1950. There are no large urban centers in the Mountain-Foothills area of this watershed. Atlanta, Georgia, is in the Piedmont Plateau and Columbus, Georgia, is in the Coastal Plain Physical Land Unit.

The first settlers entered this area the latter part of the Eighteenth Century. With some possible exceptions, the early settlement of this watershed was directed toward the main stems of the major streams. Early settlers confined cultivation to the fertile bottom land along the streams, leaving the rolling upland in its native forest cover.

Climate

The geographical position of the watershed, well south in the Temperate Zone, and its proximity to the Gulf of Mexico on the south and the Atlantic Ocean on the southeast, naturally indicate a moist, warm climate. However, due to a difference in altitude from sea level to 4,463 feet in elevation and a north-south watershed length of 350 miles, there is a marked climatic variation within the watershed.

Average monthly temperatures vary from 42° during January and 76° during July in the Mountain-Foothills to 51° in January and 82° in July in the Coastal Plain. The maximum temperature reported at Columbus, Georgia, is 106° and the minimum -3°. The average length of the growing season varies generally from 200 days in the Mountain-Foothills to 250 days in the Coastal Plain. However, an average growing season for the higher elevations in the mountains is about 190 days and at Apalachicola, Florida, it is 305 days.

The mean annual precipitation is approximately 60 inches in the Mountain-Foothills, with 61 inches at the Dahlonega, Georgia, station. Averages of the stations with over 50 years record show a mean annual precipitation of approximately 50 inches in the Piedmont Plateau and 51 inches in the Coastal Plain. Rainfall characteristics vary with the season of the year. Winter rains are generally steady, gentle, seldom exceed 1½ inches per day, and occur during one-fourth to one-half of the days during each of the four winter months. Summer rains are caused chiefly by local summer convection type storms, or by widespread storms associated with West Indian hurricanes. The latter may occur any time between July 15 and November 15, and, although they are infrequent in this watershed, they are usually followed by major floods. Summer rains frequently amount to or exceed 2 or 3 inches per day. Because of this high intensity rainfall, runoff rates are high and erosion losses great. In the lower one-half of the Coastal Plain, the summer rainfall season extends into September.

Snowfall has never been an important factor in flooding in the Apalachicola River Watershed, although occasional deep snows occur in the Mountain-Foothills or northern Piedmont Plateau.

AGRICULTURAL RESOURCES AND PRESENT LAND USE

Agriculture accounts for the major portion of the occupational activity in the Apalachicola River Watershed. About 69 percent of the total watershed area is in farms and 31 percent is land not in farms. All of the non-farm lands are in forest land with the exception of 651,900 acres of miscellaneous lands which are in urban areas, roads, streams, etc. Major land use in the watershed is approximately as follows: 55 percent forest land, 25 percent cropland, 5 percent pasture, 9 percent idle, and 6 percent miscellaneous.

Peanuts, cotton, truck crops, and orchard crops are all important cash crops in the watershed. In order of acreage occupied, the most important crops in the watershed are corn, peanuts, pasture, hay and temporary grazing crops, cotton, truck and vegetable crops, small grain, and orchard crops. Tobacco occupies only a relatively small acreage in the southern end of the watershed, but, due to its high value per acre, is an important crop in the area where grown.

Livestock and livestock products are gaining rapidly in this watershed as important sources of farm income.

In the Mountain-Foothills, forests make up approximately 75 percent of the total land area and generally extend for many miles, broken only by small clearings and narrow, cultivated valleys. Throughout the hilly and gently rolling Piedmont and Coastal Plain, forests generally account for about 50 percent of the land area and usually occupy the rougher, poorer lands unsuited for cultivation. In the flat, poorly drained portions of the Coastal Plain, little land has been cleared and most of the area is in woods.

There are 5 forest types in the watershed: (1) longleaf-slash pine, (2) shortleaf-hardwoods, (3) shortleaf-loblolly-hardwoods, (4) loblolly-hardwoods, and (5) mixed bottom land-hardwoods.

The shortleaf pine-hardwoods include all of the Mountain and Foothill section in the headwaters and extend southward into the Piedmont. Small quantities of Virginia and white pine, pure or mixed, are interspersed throughout this type. Hardwoods, occurring in mixture with the pine, are chiefly red and white oaks, red and black gum, yellow poplar, and hickory. About half of the net cubic foot volume is in pine, the remainder in mixed hardwoods.

The shortleaf-loblolly hardwoods type is concentrated in the areas drained by the Chattahoochee River and mainly occurs in the western portions of the hilly Piedmont and Coastal Plain. On the rolling uplands, loblolly pine generally occupies the better sites, while shortleaf and upland hardwoods (chiefly red and white oaks, red gum, and hickory) predominate on the poorer sites. Pine comprises about half the net cubic foot volume and mixed hardwoods the remainder.

The loblolly pine-hardwood type is usually on the better sites and occurs principally on areas drained by the Flint River. Similar to the loblolly-shortleaf-hardwood type, it differs chiefly in having a higher proportion of loblolly pine.

The longleaf-slash pine type is confined entirely to the Coastal Plain and usually to the sandy soils common to this part of the watershed. Pine comprises over 75 percent of the net cubic foot volume with cypress, water tupelo, and scrub hardwoods, accounting for most of the other 25 percent.

The bottom land hardwoods type occurs on the flood plain of the main stem and tributaries of the Apalachicola River. The more abundant species are black and water tupelos, red gum, water oaks, white oaks, cypress, ash, elms, and maples.

Though generally occupying favorable growing sites, the forests of the watershed have been seriously depleted by overcutting and unwise management, and by the effects of fire, insects, and grazing. Even the better managed public and industrial holdings are understocked for optimum use of the growth potentialities of the sites.

The major portion of the forests, without good management or protection, are sparsely stocked with trees of poorer quality and species. A large proportion of the area carries only trees of seedling and sapling size, often so widely spaced as to have little promise for producing a profitable crop. Under such conditions, watershed cover is almost universally in poor condition for prevention of runoff.

On the other hand, the forests of the watershed have shown remarkable ability to recuperate from abuse and excessive cutting. Where seed sources have been available, the pines have usually occupied abandoned cropland and clear cut forests. A large part of the present growing stock consists of second growth timber which has become established without intentional effort on the part of the landowners. Such forests, though valuable, are inferior to what can be developed under careful forest management.

Due to the variations in soils, geology, topography, climate, vegetative cover, and stream characteristics and the corresponding variations in types and systems of farming, the Apalachicola River Watershed has been divided into three physical land units (see figure A-1) in order to develop and evaluate the proposed remedial program. These major separations are relatively homogeneous areas with respect to the important factors (soils, geology, vegetative cover, and stream characteristics) influencing runoff and flood control. The following table gives the area distribution of the watershed and physical land units by states.

Apalachicola River Watershed
Distribution of Physical Land Units by States
(Acres)

Physical Land Unit	Georgia	Alabama	Florida	Total
Mountain-Foothills	608,000			608,000 (950 sq.mi.)
Piedmont Plateau	3,407,620	419,580		3,827,200 (5,980 sq.mi.)
Coastal Plain	5,393,320	1,481,280	1,317,400	8,192,000 (12,800 sq.mi.)
Grand Total	9,408,940	1,900,860	1,317,400	12,627,200 (19,730 sq.mi.)
Percent	75	15	10	100.00

Mountain-Foothills

This division of the watershed includes a portion of the Blue Ridge Mountains and their southern foothills. It accounts for 5 percent of the watershed area. The mountain elevations range from 1,500 to 4,463 feet, and the foothills from 900 to 1,500 feet above sea level. The underlying rock is crystalline and is chiefly gneissic and schistose with some granitic intrusions.

The mountains have a rugged topography which is approximately 90 percent forest. The foothills, approximately 60 percent forest, have wide interstream divides which range from 1,100 feet elevation on the southwest to 1,500 feet adjacent to the mountains on the northeast. These level to gently undulating divides are remnants of a peneplain which has been dissected by stream incision. The soils on the flatter divides generally include the Cecil and associated series while the steeper slopes include Hayesville and associated series. Because of these more level areas, this portion of the foothills is sometimes referred to as the Dahlonega Plateau.

Approximately 46 percent of the Mountain-Foothills area is farm land. The average size farm is approximately 76 acres, of which 62 percent is farm forest, 7 percent open pasture, 18 percent planted cropland, and 13 percent is idle or miscellaneous farm land. Approximately 73 percent of the planted cropland is used for clean cultivated row crops.

Cotton, truck and vegetable crops, and orchard crops (principally apples) are major sources of cash farm income in this area. Livestock also furnishes an important source of cash farm income in the area, particularly on the larger farms. On an acreage basis, corn is the leading crop in the area, followed by pasture, hay, and temporary grazing crops, truck and vegetables, cotton, small grain, and orchard. A larger proportion of the farms in this area are subsistence and part-time farms than in other areas of the watershed.

Flood plain land is highly important in this area, particularly in the mountains. The rough topography and ensuing absence of any extensive areas of residual soils suitable for cultivation make it necessary to use the highly productive alluvial soils found in the flood plains, despite flood hazard. Alluvial bottom lands in the Mountain-Foothills amount to about 33,000 acres (excluding bottom lands to be inundated by the Buford Reservoir), of which about 80 percent is open land and 20 percent forest. About 50 percent of the open alluvial land is used for corn, 24 percent for hay crops, 15 percent pasture, 1 percent truck and vegetable crops, 10 percent idle, and 18 percent double cropped with small grain.

Piedmont Plateau

The Piedmont Plateau comprises approximately 30 percent of the watershed area. It is underlain by "crystalline" rock of the Wissahickon complex and granitic intrusions. In general, the former has a surface residuum 25-50 feet or more in thickness, while the latter has a thinner mantle cover, or outcrops at the surface. Where accelerated erosion has been moderate or less, surface soils are dominantly sandy loams. However, severe erosion has resulted in the removal of the original surface sandy loam layer over much of the watershed. Where this has occurred the original clay loam and clay subsoil are now exposed and are the surface soils.

The Piedmont Plateau is an upland remnant of a former peneplain into which the Chattahoochee and Flint Rivers and their tributaries have incised their channels, and rolling to steep hills have been formed by normal geologic erosion. The surface of the Plateau has an average regional slope from the foothills to the fall zone of 4 feet per mile. Pine Mountain, a broken and complex ridge, parallel to and 15-25 miles north of the fall zone, extends 60 miles eastward from the Chattahoochee River. Prominent ridges of lesser extent occur along the northwestern watershed boundary due to the presence of resistant rocks. These are Black Jack Mountain, having an elevation of 1,350 feet in Randolph County, Alabama, but extending into Georgia; White Oak Mountain, Carroll County, Georgia; Lost Mountain and Kennesaw Mountain, Cobb County, Georgia; and Suwanee Mountain, Forsyth County, Georgia.

Approximately 68 percent of the Piedmont area is farm land. The average size farm is approximately 90 acres, of which about 38 percent is farm forest, 12 percent open pasture, 30 percent planted cropland, and 20 percent is idle or miscellaneous farm land. Approximately 74 percent of the planted cropland is used for clean cultivated row crops.

Cotton is the leading cash crop in this area, but truck and vegetable crops and orchard crops (principally peaches) are also important sources of cash income. Livestock and poultry contribute heavily to the cash farm income in this area at present, also, and are making rapid strides toward becoming two of the most important sources of cash farm income in the area. At the same time, peaches are definitely on the decline as a source of income in this area.

On an acreage basis, corn is still the leading crop in the area; followed by pasture, hay and temporary grazing crops, cotton, small grain, truck and vegetable crops, and orchard.

Use of the flood plain land in the Piedmont Plateau, as a general rule, has not been so important to the survival of individual farm units as in the Mountain-Foothills area due to its smoother

topography and relative abundance of cultivable upland. In recent years a high percent of the alluvial soils in this area has reverted to swamp growth and woodland due to the high incidence of floods and deterioration of the flood plain from swamping, sanding, scouring and infertile sediment deposits. At the same time, deterioration of the upland soils from erosion has emphasized the need for productive use of both the uplands and the bottom lands through conservation farming and flood control operations.

Coastal Plain

The Coastal Plain comprises about 65 percent of the entire Apalachicola River Watershed. It is underlain by unconsolidated and semi-consolidated sands, clays, and marls, thin at the northern margin, but gradually increasing in total thickness southward and attaining depths of several thousand feet. Beneath these sedimentary formations lie the southward extension of the igneous and metamorphic rock mass of the Piedmont Plateau. The outcrop of the Tuscaloosa formation of Upper Cretaceous age underlies the fall zone sand hills, and forms a belt 10-15 miles wide at the northern margin of the Coastal Plain. Between this and the flatwoods coastal area is the extensive upper and middle coastal plain area which varies from flat to hilly, but the greater portion is undulating to gently rolling. The Gulf Coastal Flatwoods is a flat, poorly drained area which extends 25-30 miles inland from the Gulf of Mexico. Except for the smaller streams in the Sand Hills area, flood plains are wide and well developed and stream gradients are low.

Approximately 71 percent of the Coastal Plain area is farm land. The average size farm is about 112 acres, of which about 42 percent is farm forest, 6 percent open pasture, 40 percent planted cropland, and 12 percent is idle or miscellaneous farm land. Approximately 95 percent of the planted cropland is used for clean cultivated row crops.

Peanuts lead as the largest source of cash farm income in this area at present, with cotton a poor second. Although comprising a smaller proportion of the total cash farm income than in the Piedmont Plateau, truck and vegetable crops, orchard (principally pecans and peaches), and livestock are important sources of cash farm income in this area. As in the Piedmont Plateau, livestock production trends indicate that this enterprise will contribute more heavily to cash farm income in the Coastal Plain area in the future.

On an areal basis, the peanut crop occupies the largest acreage in the Coastal Plain, followed by corn, pasture, cotton, hay and temporary grazing crops, truck and vegetable crops, small grain and orchard.

The discussion of flood plain in the Piedmont Plateau applies in this area with some exceptions. Flood plains in this area are generally wider and more extensive than in the Piedmont Plateau, but are also made up predominantly of poorly drained alluvial soils, many of which cannot be profitably used in any higher state of production than now exists. However, a small proportion of the flood plain in this area is now being used for pasture, hay and row crops, and a much larger area can profitably be used for this purpose. This proportion consists principally of areas of more fertile and inherently better drained alluvial soils found in the flood plains of those streams heading in the better grade residual soil areas.

LAND CAPABILITIES

Measured data of soil conservation surveys, made by the Soil Conservation Service in the Apalachicola River Watershed, were the basic data for determination of the land capabilities for the watershed. After a careful study, these sample areas were expanded to areas for which the individual samples are representative.

The distribution of land capability classes by present land use is summarized in tables A-3, A-4, A-5, and A-6.

RUNOFF

Under present land use conditions, runoff has been accelerated throughout the greater portion of the watershed. The infiltration rate and water storage capacity of the original soils have been decreased generally.

The following changes in land use, under the proposed remedial program, would effectively reduce runoff within the watershed.

1. The remedial program would provide for the conversion of the larger portion of woodland in poor or medium hydrologic condition to good hydrologic condition. Woodland in good hydrologic condition will be maintained as such. A small portion of the woodland occurs on soils of very low infiltration rates. These low rates may represent the natural condition of the soil, or be the result of severe sheet erosion or other land misuse. Even under the best of management, the infiltration rates on these areas can be increased only slightly.

2. All idle land will be used for cropland, pasture, woodland, perennial vegetation, or for wildlife refuge and cover, according to its land capability and needs.

3. All cropland of capability classes I, II, and III, and part of IV will be retained as cropland. Soil conservation practices such as improved rotations and permanent vegetative strips will result in improved condition of the land retained as cropland.

4. A part of class IV land and all of classes VI and VII now in cropland will be used for pasture, woodland, perennial vegetation, or wildlife refuge and cover.

5. Pasture improvement and management will improve the hydrologic condition of pastured areas, thereby reducing runoff.

6. Miscellaneous areas consist of farm homesites, urban areas, lakes, stream channels, roadways and railways. Stabilization of drainageways, cuts, and fills along roadways and railways is recommended. There will be little or no reduction of runoff in miscellaneous areas such as farm homesites and urban areas.

EROSION

Permanent damage to bottom lands often occurs if the upland removals are sand, gravel, or coarser grained sediment. If these materials reach the stream channel, they become bed load, thereby reducing the channel capacity. The result is a rise in the stream water level and the water table within the alluvial soils that comprise the contiguous bottom lands. This process in its ultimate phases causes swamping of once productive bottom lands. Another type of damage by coarse erosional debris occurs where splays are deposited on bottom lands, or fertile soils are scoured, during floods.

Although the coarser erosional debris is responsible for the greater portion of the permanent land damage, the finer materials cause serious damage of a different nature. Forage plants are rendered unpalatable, temporarily, by deposition of fine material on the foliage. High turbidities, the result of fine material in suspension, increase filtration costs of municipal water supplies. The latter may also be harmful to fish or other aquatic life.

Sheet Erosion

Active sheet erosion is most severe in the Piedmont Plateau. According to an estimate based on soil conservation surveys, about 40 percent of the Piedmont Plateau portion of the watershed has a clay loam or clay surface soil, as the result of accelerated erosion. These soils, under original conditions, had a sandy loam topsoil averaging 6 to 8 inches in thickness, underlain by a clay loam or clay subsoil averaging 24 to 30 inches in thickness.

The present area of upland sandy loams in the Piedmont Plateau of the watershed comprises about 50 percent of this physical land unit. Because a large portion of these soils are not stabilized, sheet erosion contributes a large aggregate volume of sand and gravel from these areas. Some of this becomes small colluvial deposits on the lower edges of fields, along fences, or in intermittent drainageways. However, the major portion of the coarse sediment from sheet erosion finds its way to stream channels where it becomes bed load and/or sand deposits on the flood plain.

Sheet erosion is a serious problem in portions of the Mountain-Foothills and Coastal Plain. However, permanent damage due to coarse erosional debris from areas subject to accelerated sheet erosion is not so evident in these two physical land units as in the Piedmont Plateau.

Gully Erosion

Active gullying is most serious throughout the Piedmont Plateau and in portions of the Upper Coastal Plain. There are an estimated 18,684 miles of active gullies in the entire watershed. About 57 percent of the active gullying occurs in the Piedmont Plateau, although this comprises only 30 percent of the land area. Gullies in this physical land unit are an important source of infertile and injurious sediment. The largest and most rapidly eroding gullies are in the Upper Coastal Plain. This is particularly true, as in the Providence "Canyon" areas, where a thick, loose sand formation (Providence formation) is capped by a tight, thin, clayey sand formation (Clayton formation).

Although active gully erosion is more spectacular than sheet erosion, it is generally less widespread. Gully erosion is usually less serious than sheet erosion as judged by the total resulting damage to uplands.

As a source of harmful sediment, however, gully erosion is obviously more important than sheet erosion in proportion to the area affected. This is notably true in the foothills portion of the Mountain-Foothills, the Piedmont Plateau, and the middle and upper portions of the Upper Coastal Plain. Above the fall zone, the bedrock is commonly weathered and disintegrated to depths of 25-50 feet and in some places more than 100 feet. In the Coastal Plain, gullying is at its worst where a loose, unconsolidated formation of considerable thickness underlies a comparatively thin, compact, clayey sand formation.

Roadway and Railway

Roadway and railway cuts, fills, and drainageways, which have not been stabilized, constitute another and very important source of erosional debris. This is particularly true of unimproved roads in the Piedmont Plateau and Foothills. Here roadside cuts, fills, and drainageways are generally unprotected and seriously eroded. Some abandoned road sites have been reduced to one large gully at the site of the old roadway.

GROUND WATER

Mountain-Foothills and Piedmont Plateau

The Mountain-Foothills and Piedmont Plateau are underlain by Pre-Cambrian rocks and later intrusions. These are chiefly gneiss, schist, and granites which yield ground water from the weathered

upper portion or surface residuum, and from joints which occur within a few hundred feet of the surface. In general, shallow dug wells in the weathered surface zone and springs are the source of rural domestic and stock water supplies. There are no records to show the total amount of ground water consumed on farms. Deeper drilled wells and larger springs supply water for small municipalities and industry. Ground water consumption by municipalities and industry in the Mountain-Foothills and Piedmont Plateau within the Apalachicola River Watershed amounts to approximately 976,000,000 gallons annually. In contrast, 18,970,000,000 gallons are consumed annually by municipalities and industry which obtain their supplies from surface water.

Coastal Plain

Except for the northern fringe of the Coastal Plain, where Columbus, Georgia, and Phenix City, Alabama, obtain their water supply from the Chattahoochee River, ground water is the chief source of water supply in both rural and urban areas. A large part of the rural water supplies is obtained from shallow dug wells. However, there are many drilled wells of small diameter that furnish ground water for domestic and livestock needs.

About 1,695,000,000 gallons of ground water are consumed annually by cities, towns, and villages within the Coastal Plain portion of the watershed. This includes water obtained under both artesian and water table conditions.

Important ground water supplies are obtained from a number of Upper Cretaceous and Tertiary formations. However, the principal artesian aquifers are limestones of Eocene and Oligocene age. These formations are exposed in a belt extending across the watershed from the western watershed boundary in Houston County, Alabama, and Jackson County, Florida, to the eastern watershed boundary in Macon, Houston, and Dooly Counties, Georgia. This area of outcrop, where most of recharge appears to enter the formations, is elongated from southwest to northeast. The area has a length, within the watershed, of 150 miles and the width varies from 10 to 50 miles. Figure A-2 shows the area of outcrop of the principal artesian aquifers.

A portion of the water which enters the ground as influent seepage in the aforementioned recharge area, is eventually obtained, through artesian wells, in areas nearer the Gulf of Mexico and Atlantic Ocean. A study of piezometric maps shows that some of the water, so recharged, would flow southward in the area which underlies the Apalachicola River Watershed. Much of it would flow to the west and east of the watershed, however, and would be tapped by wells in other watersheds. Thus a part of the influent seepage in the Apalachicola River Watershed is discharged through artesian wells in cities such as Panama City, Florida; Tallahassee, Florida; Brunswick, Georgia; and through many other artesian wells in the same general area.

FLOOD PROBLEMS

The size of the area, its physiographic variations, and storm characteristics are such that major flood producing storms covering the entire area have rarely occurred. During the spring months, particularly March, high winds of cyclonic origin come into the area from the west and often produce intense local storms with heavy rainfall accompanied by tornadic winds. Such a storm occurring in March 1929 produced the highest stage of record at the junction point of the Chattahoochee and Flint River tributaries.

The December 1919 flood was the greatest of record on the Chattahoochee at West Point, Georgia. The March 1929 storm, mentioned above, was the highest of record for the lower Chattahoochee, below the fall line, and Apalachicola River main stem. At Albany and Bainbridge, Georgia, the Flint River reached its highest stage of record in January 1925.

Violent local storms, of both frontal and convective types, in the Mountain areas create flash floods, the force of which is dissipated before the flood flows progress very farm downstream. However, those floods often cause severe land damages to stream banks and channels and to adjoining bottom lands. Also, prolonged periods of rainfall in the Piedmont Plateau area cause overflow of longer duration on tributary streams. However, those tributary flows are often absorbed by the main stream without appreciable rises in stage.

Flood damages which may be alleviated by improved cover conditions, channel improvement, floodwater retarding structures, or a combination of these, are predominantly those which occur on the flood plains of tributary streams and on the upper reaches of the Chattahoochee and Flint Rivers, principally above the fall line. On each of these tributaries, an average of about three floods occurs annually. Damages due to inundation occur on all of the Mountain-Foothill and Piedmont tributaries and on many Coastal Plain tributaries. Damages due to accelerated sedimentation are most highly concentrated in the Piedmont Plateau, where sheet, gully, and roadway erosion is most severe. Reduction in sedimentation damages can be achieved by improved land use and gully and roadway erosion control.

Flood problems along the middle and lower reaches of the main stems of the major streams are largely caused by the comparatively infrequent storms covering large areas of the watershed for prolonged periods of time. When such flood producing storms occur, they cause considerable urban and industrial damages as well as damages to agriculture. Due to the nature of the storms producing these high flood crests, downstream recommended remedial measures are expected to have little, if any, significant influence on damages due to inundation.

DRAINAGE ENTERPRISES

In the past, there have been several drainage enterprises in the Apalachicola River Watershed. These organizations have been inoperative for many years. It is anticipated that there will be a resumption of drainage activities in the watershed when the flood control remedial program is initiated.

INDUSTRY

Manufacturing in the Apalachicola River Watershed is principally the initial processing of farm products produced in the area. The textile industry is probably the most important in the area. This industry is comprised principally of the cotton textile mills, but also includes mills producing other textile products. Other plants in the area closely associated with agriculture are cotton gins, cotton and peanut oil mills, canning plants, sawmills, paper mills (processing pulpwood), veneer mills, turpentine stills, fertilizer plants, meat packing plants, flour and feed mills.

Plants not so closely associated with agriculture but of importance in the area are gas and electric power plants, bottling works, brickyards, ice plants, machine shops and foundries. There is one large steel ingot mill in Atlanta, Georgia; a large aeroplane plant near Marietta, Georgia; a bauxite plant at Eufaula, Alabama; and a large fuller's earth plant at Attapulgus, Georgia.

In addition to its importance as the Georgia State Capital and for its many industries, Atlanta, Georgia, also serves as one of the most important inland transportation centers in the South. A relatively high percent of all east-west and north-south rail and highway traffic is funnelled through this southern metropolis.

Lumber and other wood product industries have long been important factors in the economy of the watershed. In colonial days, squared pine and cypress timbers for export and live oak for ship timbers were the principal wood products. Beginning in the longleaf-slash pine forests of the Coastal Plain, the forest industries gradually spread northward to the mountains and expanded from a negligible production by a few sawmills in the early 1800's to a peak output in 1946 when more than 215,000,000 cubic feet were harvested. Production records for years 1947 to 1950 indicate only a slight decline from the 1946 peak.

Lumber now accounts for more than 50 percent of the net cubic foot production of wood products with fuelwood, pulpwood, veneer logs, cooperage bolts, hewn ties, posts, dimension stock, piling, and poles following in order of volume harvested. The harvesting of gum from living longleaf and slash pines and its processing into rosin and turpentine also is of major importance to the watershed economy.

Extremely heavy cutting during the past few decades has left much of the forest land badly depleted and understocked. The cut is presently concentrated in the better classes of timber, thereby causing a progressive decline in quality of growing stock. Improved fire protection and management have helped keep total growth, including that on small or unmerchantable trees, about equal to drain. Current production, if maintained, will lead to further depletion of saw timber reserves and a general decline in stand quality.

The annual cut of all wood products is estimated at 215 million cubic feet. Its value, in rough manufactured form, is about $46,650,000. This amounts to an average cut of 31.5 cubic feet per forest acre or an annual contribution to the watershed economy of $6.79 per acre.

Since timber cutting has not greatly exceeded growth in recent years, it is not expected that the volume available for cutting will decline in the future, even without the recommended watershed program. Total growth is expected to increase somewhat as the result of planting and fire protection programs, and good management on part of the landowner. On the other hand, continued overcutting of the higher quality growing stock will inevitably reduce future average values. Within forty years it is estimated that the total annual cut will reach about 300 million cubic feet, with a value of about $51,700,000. The proportion of high value products such as sawlogs, poles, and piling in this cut will be considerably below the present, and very much lower than would be obtained under the recommended program.

OWNERSHIP OF LAND

In the early part of 1951 approximately 510,000 acres of land in the Apalachicola River Watershed were publicly owned. Of this amount, 216,096 acres were in national forests, approximately 204,500 acres were in military reservations, and approximately 75,000 acres had been purchased for reservoir areas. The remaining acreage was occupied by state and local parks, national parks, and cemeteries. See figure A-3 for location of larger areas.

Farm Land

The farm ownership pattern varies widely in this watershed from one physical land unit to the other (see table A-1), varying in 1945 from a low of 35 percent tenancy in the Mountain-Foothills Physical Land Unit to a high of 63 percent tenancy in the Coastal Plain area. However, there was a noticeable decline in the percentage of farm operators who were tenants in all areas of the watershed from 1940 to 1945.

It is recognized that the high percentage of tenant farmers in this watershed may adversely affect the rate of establishment of the proposed flood control measures. At the same time, however, the present trend toward fewer tenant operated farms indicates that this problem may well be less acute in the future.

Forest Land

Forest lands total about 6,868,000 acres or 54.4 percent of the watershed. Farm woodland comprises 3,575,000 acres or 28.3 percent of the watershed; national forests 216,000 acres or 1.7 percent; other public forests 153,000 acres or 1.2 percent; and private non-farm woodland 2,924,000 acres or 23.2 percent.

Forest lands in public ownership, with the exception of parks and recreation areas, are generally managed primarily for timber production and watershed protection, but with full conservation and use of all resources a fundamental management objective. The 14,000 acres of state parks and national monuments in the watershed, though managed chiefly for recreation, receive intensive fire protection and management which, in the main, meets watershed protection requirements.

Of the 6,499,000 acres of private forest lands, 55 percent is held by farmers as parts of farm enterprises. The remainder is in a variety of ownerships with industrial holdings comprising a large proportion of the total. The larger holdings, usually in parcels of 20,000 acres or more, are for the most part under good management.

LEGISLATIVE FACTORS

Alabama, Florida, and Georgia have enacted legislation under which soil conservation districts were organized and were actively operating throughout the watershed in 1950. All counties wholly or partially within the watershed were in organized soil conservation districts except Franklin and Liberty Counties, Florida; Franklin County and a part of Fulton County, Georgia.

All three states have laws for the organization of drainage districts, but when the field phase of the flood control survey was completed (1949), no operating drainage districts were located within the watershed boundary.

The Weeks Act of 1911 and the Clarke-McNary Act of 1924 provide for federal acquisition of forest land for watershed protection or timber production provided the states consent to such acquisition. The states of Georgia[1/], Florida, and Alabama have passed

1/ Purchase in Georgia is limited to the following counties: All those counties in the northern and central portions of the state south to and including the following counties: Stewart, Webster, Marion, Taylor, Upson, Monroe, Jones, Putnam, Greene, Taliaferro, Wilkes, Jasper, Elbert, Warren, Hancock, Oglethorpe, Dodge, Treutlen, Laurens, Butts, and Richmond, and in the Okefenokee Swamp.

enabling acts consenting to federal acquisition. However, the Flood Control Act of 1944 requires specific state enabling legislation for acquisition of lands for flood control purposes. Need for such legislation has not developed as yet in these states.

The Clarke-McNary Act of 1924 provided for federal-state cooperation on a fund matching basis in forest fire control and tree planting. The Norris-Doxey Farm Forestry Act of 1937 provides for federal contributions to the states for technical assistance to small owners in forest land management, including advice and guidance in planting and silvicultural treatment, woodland protection; and the harvesting, utilization, and marketing of forest products.

The Cooperative Forest Management Act, Public Law 729, replaced on June 30, 1951, the Norris-Doxey Farm Forestry Act of 1937. The new act provides that federal cooperation will channel through state foresters, and it broadens the present authorization to permit extending these services to non-farm owners and operators and to processors of primary forest products.

Table A-1. Farm Tenancy in the Apalachicola River Watershed

Area	Farm Operators Who Were Tenants	
	1940	1945
	(percent)	(percent)
Mountain-Foothills	43	35
Piedmont Plateau	59	52
Coastal Plain	67	63
Apalachicola River Watershed	63	58

Table A-2. Present Ownership of Forest Land
Apalachicola River Watershed

Ownership	Public	Private	Total
	(acres)	(acres)	(acres)
Apalachicola National Forest (Florida)	116,968		116,968
Chattahoochee National Forest (Georgia)	99,128		99,128
Military Reservations	139,220		139,220
National Battlefield Sites	2,098		2,098
State and Local Parks and Forests	11,312		11,312
Farm Forests	--	3,574,589	3,574,589
Non-farm Forests	--	2,924,467	2,924,467
Total	368,726	6,499,056	6,867,782

Table A-3. Distribution of Land in the Mountain-Foothills Physical Land Unit Showing Present Land Use by Land Capability Classes
Apalachicola River Watershed

Land Capability		Present Land Use				
Class	Subclass	Cropland	Woodland	Idle Land	Pasture	Total
		(acres)	(acres)	(acres)	(acres)	(acres)
I		20,153	5,178	2,498	1,644	29,473
	e	5,795	11,261	1,238	1,644	19,938
II	w	2,129	257	186	153	2,725
	s	293	101	27	61	482
III	e	11,953	40,654	7,101	5,351	65,059
IV	e	5,619	40,307	5,541	4,021	55,488
V	w	377	1,501	400	505	2,783
VI	e	342	101,231	268	768	102,609
VII	e	3,861	240,917	14,798	5,782	265,358
VIII	s	0	18	6	0	24
Subtotal		50,522	441,425	32,063	19,929	543,939
Miscellaneous						64,061
Total						608,000

Table A-4. Distribution of Land in the Piedmont Plateau Physical Land Unit Showing Present Land Use by Land Capability Classes Apalachicola River Watershed

Land Capability Class	Subclass	Present Land Use: Cropland	Woodland	Idle Land	Pasture	Total
		(acres)	(acres)	(acres)	(acres)	(acres)
I		24,813	33,409	4,527	10,591	73,340
II	e	76,206	32,434	15,511	46,249	170,400
	w	12,459	38,975	3,454	6,413	61,301
III	e	295,619	137,820	73,154	50,899	557,492
	w	7,683	15,617	448	2,265	26,013
	s	0	66	79	0	145
IV	e	190,107	220,213	97,102	52,285	559,707
	s	61	1,841	3	0	1,905
V	w	4,199	164,208	4,770	8,589	181,766
VI	e	61,564	292,021	39,341	34,576	427,502
VII	e	122,838	1,055,577	240,829	112,740	1,529,984
	s	0	19,803	105	0	19,908
Subtotal		795,549	2,009,984	479,323	324,607	3,609,463
Miscellaneous						217,737
Total						3,827,200

Table A-5. Distribution of Land in the Coastal Plain Physical Land Unit Showing Present Land Use by Land Capability Classes Apalachicola River Watershed

Land Capability Class	Subclass	Present Land Use: Cropland	Woodland	Idle Land	Pasture	Total
		(acres)	(acres)	(acres)	(acres)	(acres)
I		212,823	113,528	35,030	10,433	371,814
II	e	1,066,461	304,154	109,817	54,062	1,534,494
	w	2,773	17,933	3,240	8,970	32,916
	s	198,569	157,722	30,471	6,861	393,623
III	e	355,722	424,883	91,190	29,864	901,659
	w	43,900	286,689	22,341	62,465	415,395
	s	170,269	458,219	52,937	15,024	696,449
IV	e	114,318	229,443	58,509	13,654	415,924
	w	4,249	25,085	4,805	26,655	60,794
	s	37,484	95,989	33,729	5,191	172,393
V	e	8,135	78,916	8,755	534	96,340
	w	22,572	1,184,142	38,112	68,469	1,313,295
	s	317	3,157	593	570	4,637
VI	e	22,504	75,732	13,021	711	111,968
	s	7,584	25,683	2,733	934	36,934
VII	e	72,404	802,725	125,731	15,306	1,016,166
	s	7,849	104,113	11,080	3,322	126,364
VIII	w	29	27,768	40	40	27,877
	s	0	492	0	814	1,306
Subtotal		2,347,962	4,416,373	642,134	323,879	7,730,348
Miscellaneous						461,652
Total						8,192,000

Table A-6. Summary of Distribution of Land in the Entire Apalachicola River Watershed, Showing Present Land Use by Land Capability Classes

Land Capability Class	Subclass	Present Land Use: Cropland	Woodland	Idle Land	Pasture	Total
		(acres)	(acres)	(acres)	(acres)	(acres)
I		257,789	152,115	42,055	22,668	474,627
II	e	1,148,462	347,849	126,566	101,955	1,724,832
	w	17,361	57,165	6,880	15,536	96,942
	s	198,862	157,823	30,498	6,922	394,105
III	e	663,294	603,357	171,445	86,114	1,524,210
	w	51,583	302,306	22,789	64,730	441,408
	s	170,269	458,285	53,016	15,024	696,594
IV	e	310,044	489,963	161,152	69,960	1,031,119
	w	4,249	25,085	4,805	26,655	60,794
	s	37,545	97,830	33,732	5,191	174,298
V	e	8,135	78,916	8,755	534	96,340
	w	27,148	1,349,851	43,282	77,563	1,497,844
	s	317	3,157	593	570	4,637
VI	e	84,410	468,984	52,630	36,055	642,079
	s	7,584	25,683	2,733	934	36,934
VII	e	199,103	2,097,219	381,358	133,828	2,811,508
	s	7,849	123,916	11,185	3,322	146,272
VIII	w	29	27,768	40	40	27,877
	s	0	510	6	814	1,330
Subtotal		3,194,033	6,867,782	1,153,520	668,415	11,883,750
Miscellaneous						743,450
Total						12,627,200

FIGURE A-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M. SALTER, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL DIRECTOR

APALACHICOLA RIVER WATERSHED

IN

ALABAMA, FLORIDA, AND GEORGIA

10 0 10 20 30 40 MILES

REV. 11-30-51

2-1-7661-4

FIGURE A-2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M. SALTER, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL DIRECTOR

AREAS OF OUTCROP OF PRINCIPAL ARTESIAN AQUIFERS

APALACHICOLA RIVER WATERSHED

IN

ALABAMA, FLORIDA, AND GEORGIA

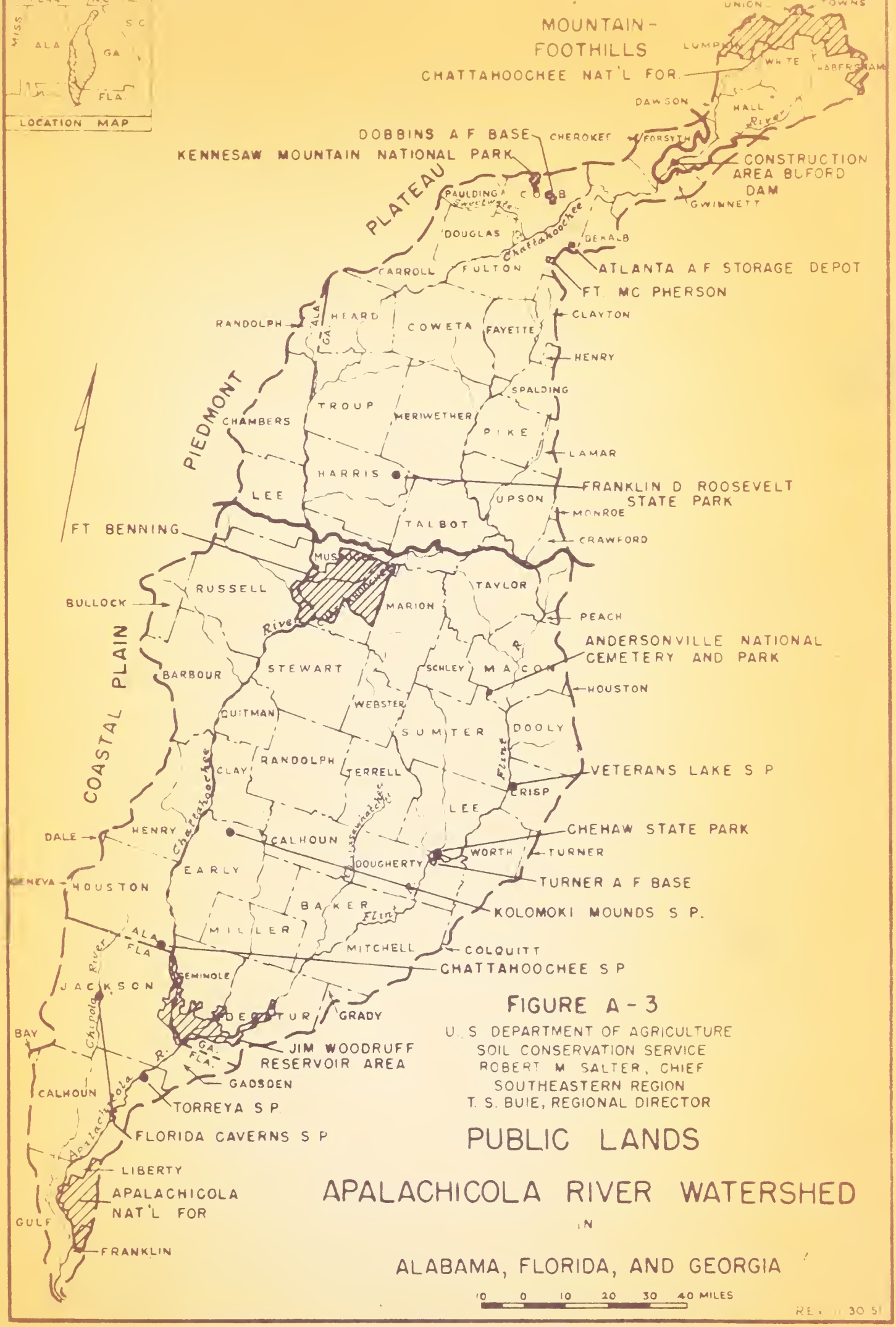


FIGURE A-3

U. S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M SALTER, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL DIRECTOR

PUBLIC LANDS

APALACHICOLA RIVER WATERSHED

IN

ALABAMA, FLORIDA, AND GEORGIA

RE. 11 30 51

2-L-7661-C

APPENDIX B

PLAN OF IMPROVEMENT

INTRODUCTION

The recommended watershed treatment program for the Apalachicola River drainage basin in Georgia, Alabama, and Florida has been developed with the primary objective of alleviating floodwater and sediment damages.

Special consideration has been given to those measures which will result in maximum flood control and water conservation benefits. The interrelation between such measures and sound land use necessitates the development of a complete system of soil and water conservation as an integral part of the recommended program if maximum benefits are to be realized.

For evaluation purposes, all measures included in the recommended program have been grouped as follows:

I - All land treatment measures and other measures closely associated with land treatment.

II - Additional measures supplemental to land treatment measures.

Procedure Used in Developing Recommended Program

Present land use and physical land conditions, indicated by U. S. Agricultural Census and land capability classes, respectively, were used as basic data in developing information on the present condition of the watershed (tables A-3, 4, 5, and 6, Appendix A). Recommendations for open land treatment were developed on the basis of an average farm in each physical land area to show the needs for treatment within the watershed. These recommendations were based on the experience of Soil Conservation Service and other local agricultural workers and that of local soil conservation district supervisors and farmers. Accomplishments on farms through June 1950 were considered in estimating needs in kinds and amounts of measures. Recommendations for forest land treatment are based on procedures hereinafter described under the heading "Forest Land."

More tha 98 percent of the entire watershed area is in active soil conservation districts. Field experience of district personnel and that of other agencies was considered basic in developing the recommended program. In this connection, conferences were held with supervisors of local soil conservation districts and technicians and representatives of local agricultural agencies. At each of these conferences data was presented indicating present land use as revealed by the 1945 U. S. Agricultural Census and other acceptable sources of information Tabulations were also shown indicating the acreage by land capability classes in each land use, as obtained from sample soil conservation surveys. Using these data as a basis,

also taking into consideration local agricultural trends including availability of farm labor and present economic conditions, the local group recommended land use changes, as well as the conservation practices needed, in order to apply a complete watershed program in their respective areas.

These recommendations were adjusted to and summarized by major physical land units. These physical land units are shown in figure B-1. The significant changes are decreased rotated cropland, 290,805 acres; increased pasture, 104,920 acres; increased forest land, 68,166 acres; increased perennial vegetation, 209,021 acres; increased areas for wildlife, 11,460 acres; and the application of beneficial measures to 102,762 acres of idle land.

The land use expected at the end of the 15-year period of installation, with and without the recommended program, together with net changes by physical land units are shown in table B-1.

In developing the recommendations contained herein, records and reports of the various agencies concerned were analyzed and considered. The fiscal year 1950 was used as a basis for estimating the annual rate of accomplishments on farms cooperating with soil conservation districts. Calendar year 1947 for Georgia and 1949 for Alabama and Florida were considered most representative as to accomplishment rates for the Production and Marketing Administration.

An estimate of watershed needs by measures and the recommended program are shown in table B-2.

I. LAND TREATMENT MEASURES

Open Land

The proposed openland measures and practices for both flood control and conservation of watershed lands will conserve soil and water, improve infiltration, reduce runoff, and increase soil fertility. This will be accomplished through changes in land use and the adoption of improved cultural and management practices. The proposed measures and practices for open land are: (1) subwatershed waterways, (2) gully stabilization and sediment control, (3) erosion control along roads and railroads, (4) terraces and field diversions, (5) perennial vegetation establishment, (6) perennial vegetation improvement, (7) pasture establishment, (8) pasture improvement, (9) wildlife area plantings, (10) farm waterways, and (11) other farm and water conservation practices and measures, including technical and educational assistance and testing the effectiveness of the program.

It is recommended that the greater proportion of crop, idle, and pasture lands in capability class VII (tables A-3, 4, and 5, Appendix A) be planted to perennials or trees. The remaining acreage, which consists of areas having little or no erosion, will remain in or be converted to pasture. These areas are important sources of silt and accelerated runoff which increase flood hazards and damages.

The larger portion of such areas is recommended for perennials since they afford immediate protection to the land and will give a larger permanent return from hay or pasture, as well as increased food and cover for wildlife.

The recommended program imposes no major change in the production of cash crops. However, sound land use requirements make some reduction necessary in the acreage of clean-tilled row crops. The principal cash crops will continue to be peanuts and cotton. In the mountains fruits and vegetables will continue to be important sources of income. The proposed increase in area of pasture and close-growing crops and the decrease in area of row crops is in keeping with current trends toward increased production of livestock, which necessitates substantially increased pasture and hay crops. The increased pasture and hay crop acreage also means an increased safety margin in using the land within its capabilities. Row crop acres in approved crop rotations, on the better classes of land requiring less complex conservation measures, will be sufficient for economic needs.

These necessary conservation measures and land use changes serve a dual purpose in the recommended program: First, they reduce runoff and sedimentation from critical silt-source areas, which are distinct public benefits; secondly, they conserve soil and water and improve land with accompanying increased revenue to landowners, thereby resulting in private benefits. They do not include measures or practices for the primary purpose of increasing production.

The program includes the following practices and measures, most of which have been adopted to a limited degree by farmers in or near the watershed or have otherwise proven effective.

Subwatershed Waterways

The waterways on individual farms discharge storm runoff into secondary channels which in turn flow through other farms and finally discharge into the tributary streams. This concentrated volume of uncontrolled runoff produces excessive scour in the secondary channels which will seriously damage the bottom lands by deposition of harmful sediment. It is therefore important that adequate water disposal systems be planned, established, and maintained as group enterprises.

When the water disposal system of two or more individual farms discharges into a common outlet, it is necessary to provide adequate channel capacity, as well as apply measures which will prevent both excessive scour and the formation of gullies. In some cases, this difficulty can be alleviated only by providing channel outlets entirely across the flood plains to the tributary stream outlets. The disposal of water from hill lands without flood damage to fertile bottom lands is dependent on adequate channel outlets.

In some cases, the topography will permit the establishment of perennial vegetative outlets for group water disposal systems. Where secondary channels exist, brushing operations and some grading may be necessary to prevent meandering and the impediment of stream flow. In some instances, structures may be necessary where large quantities of runoff or eroding soils occur.

Approximately 3,420 miles of subwatershed waterways will require treatment.

Gully Stabilization and Sediment Control

Gullies are one of the principal sources of sediment. The effectiveness of the recommended program in reducing sedimentation damages depends to a large extent on the control of gully erosion.

It is estimated that there are approximately 6,100 miles of major gullies in open land and 12,584 miles in forest land which will require treatment. This estimated amount of gully treatment does not include occasional gullies which will be stabilized under normal conservation farm operations.

Gully treatment will consist of vegetative stabilization and supporting structural measures as required. Mulching, small check dams, and structural measures will facilitate the establishment of kudzu, sericea, grass, shrubs, trees, and other perennials. Adapted species of trees will be given first consideration in stabilizing gullied areas within forest lands. Temporary dikes and diversion ditches will be constructed to intercept and divert runoff from overlying areas into stabilized waterways where practicable. Fence construction and vegetative barriers will be used where necessary for protection of such areas from grazing.

Sediment can be controlled by measures that spread and reduce the velocity of surface runoff and flood flows. Vegetative barriers are most effective; however, temporary earth dams may be used at the mouth of large gullies until vegetation can be established. Plants that are close growing, deep rooted, with low, dense foliage which is not readily eaten by stock are recommended. Usually, low value bottom land or lands already damaged by deposition will be used for desilting areas.

Erosion Control Along Roads and Railroads

Road bank stabilization - A reconnaissance survey in each physical land unit within the watershed was made to determine the present condition of road cuts and fills as a basis for estimating the types and amounts of erosion control measures necessary for stabilization.

The road system lends itself to classification by three types: principal highways (hard surface); improved roads (graded soil type and surface treated); and unimproved roads (privately maintained).

The principal highways will require the greatest amounts of stabilization measures. Alignment and grade on these highways produce larger cut and fill areas per mile of highway.

Improved roads will require smaller amounts of stabilization measures than principal highways but larger amounts than unimproved roads. Existing gullies adjacent to roads will also require vegetative stabilization measures.

Unimproved roads are ordinarily fairly well stabilized and will generally be controlled in connection with the regular land treatment program.

Recommended treatment measures for road bank erosion control consist of stabilizing structures and vegetative plantings as may be required on all highways and public roads within the watershed.

The treatment measures on roads will generally consist of seedbed preparation, including fertilization, seeding or planting of vegetative cover, as well as mulching steep slopes. Suitable vegetation will be planted along outfall ditches and other silt-source areas. Structures will be used where high runoff velocities or erosion hazards make vegetative measures inadequate.

Vine type perennial vegetation is generally recommended for the deep and steeply cut slopes and ditch sections. Perennials and reseeding types of vegetation are recommended for the flatter slopes where conditions are favorable for their growth. Approximately 12,312 miles of road cuts and fills will require treatment, consisting of stabilizing structures and vegetative planting.

Railroad bank stabilization - Erosion control along railroad rights-of-way differs from that along highways in that the fill slopes along railways are usually protected with adequate vegetation in order to protect the roadbed. However, the steep, unprotected cut slopes contribute silt, and it is these areas on which the major portion of vegetative planting is recommended. It is estimated that 512 miles of cut slopes will require vegetative treatment.

Terraces and Field Diversions

Terraces will be installed to manage the runoff from sloping lands, principally those in cultivation, and to reduce soil erosion and sediment damage. Field diversions will generally be installed on slopes, and at toe-slopes, too steep for terraces but where orderly discharge of surface runoff is necessary for the protection of lands lying immediately below. It is recommended that diversions be permanently vegetated and used for pasture or hay. Approximately 132,820 miles of terraces and 19,390 miles of diversions are recommended.

Perennial Vegetation Establishment

Combinations of perennial grasses and legumes in the proposed program serve a dual purpose: First, they afford immediate protection to the land from serious erosion and runoff problems; secondly, they provide hay and grazing for livestock. Establishment measures such as land preparation, fertilizing, liming, seeding, and others will be necessary on about 209,020 acres to attain desirable hydrologic conditions on these lands.

Pasture Improvement

About 133,680 acres of old pasture lands will need additional treatment such as fertilizing, liming, seeding, and other renovating measures in order to improve the hydrologic condition to a desirable level.

These renovating measures will provide heavy-duty vegetation for the poorer classes of land which would otherwise require more complex and expensive measures in order to materially reduce runoff and sediment damages and, with proper maintenance and grazing practices, will provide additional pasture for an expected increase in livestock production.

Perennial Vegetation Improvement

About 111,720 acres of existing perennial vegetation will need additional treatment such as fertilizing, liming, over-seeding with other grasses or legumes, and other renovating measures in order to improve hydrologic condition to a desirable level.

Improved stands of perennial grass and legume combinations afford immediate protection to the land from serious erosion and runoff problems and provide hay and grazing for livestock. Fence construction will be necessary in some areas to control grazing.

Pasture Establishment

About 104,920 acres of cropland, idle land, and brushy woodland will be planted to adapted grasses and legumes for permanent pasture. Required treatment will include some clearing, land preparation, liming, fertilizing, seeding, fencing, and other measures necessary to establish and maintain good cover conditions. This acreage, adequately covered in sod-forming vegetation, will contribute materially to the reduction of runoff and sediment damages. In addition, with proper maintenance and grazing practices, an increase in pasturage will be provided for an expected increase in livestock production.

Wildlife Area Plantings

Small irregular and inaccessible areas, as well as narrow strips of land along field borders often left idle, are sources of serious erosional debris and present annoying runoff problems. It is proposed that this condition be corrected by planting approximately 11,460 acres of such areas to adapted plants that will control erosion and produce food and cover for wildlife. Fences will be constructed or vegetative fences planted where necessary to furnish protection from grazing.

Farm Waterways

Farm waterways will consist of both natural and artificial water courses to provide safe disposal of excess water from farms. Farm waterways will, in most cases, be vegetated and will include such measures as broad meadow strips, constructed channels, and vegetated terrace outlets. The natural topography of adjacent farms will

determine the planning and installation of water disposal systems in order that the water disposal systems of all farms involved may operate as a unit. Waterways will usually extend from the top of terraced slopes to suitable outlets, and follow natural drainage depressions wherever possible. In some cases it will be necessary for waterways to cross flood plain land to reach suitable outlets. The proper disposal of excess water from farm land into adequate outlets will reduce sediment damage to lower lying lands and minimize consequent reduction in yields to these lands. Supporting structures will be installed to supplement vegetative control where necessary. It is estimated that 63,780 acres of farm waterways will need to be treated.

Forest Land

The recommended forest program and its corresponding evaluation are at those levels that it is estimated can be achieved without new legislation providing for public control of forest practices on privately-owned forest land.

The quantities of measures proposed for private forest lands reflect the best available estimates of the forest improvement work that can be installed and maintained effectively under existing cooperative programs. Without appropriate safeguards, such as some form of public control of forest practices on private land, satisfactory maintenance of certain forest measures cannot reasonably be expected on a portion of the area. Accordingly, tree planting and cover improvement, as recommended herein, are limited to lands on which it is estimated these measures will be suitably maintained.

Fire Protection

Improved fire protection is recommended for 6,653,000 acres of forest land with the objective of limiting the annual burn to 0.25 percent in the Mountain-Foothills; 0.5 percent in the Piedmont and in the shortleaf-loblolly-hardwood forests of the Coastal Plain; and 1.0 percent in the longleaf pine belt.

At present about one-third of the private forest land--some 2,229,000 acres--lacks any organized fire protection. All of this is in Georgia, except some 35,000 acres in Florida. It is estimated that all of these lands will be brought under organized protection within 15 years under the cooperative, Federal-State program now under way in the watershed, and also that there will be some intensification of the fire protection system which serves the lands now under protection.

Fire records for the past five years on protected private forest land show that the annual burn has averaged between 1.0 and 2.5 percent for the three states involved. It is estimated that 10 percent or more of the unprotected land burns annually.

Fire protection afforded national forest lands in the Chattahoochee and Apalachicola National Forests is adequate for flood control purposes, and no intensification of protection is proposed herein. On private lands, however, there is evident need for strengthening

protection over and above that to be provided under "going" programs. Recommendations therefore provide for intensified protection for some 6,601,400 acres of private forest land and for 51,250 acres of lands to be publicly acquired. This contemplates that full use will be made of tools, equipment, personnel, and other facilities afforded by the "going" program. Estimates provide for only the additional personnel and facilities for strengthening existing or planned state fire organizations to bring protection up to the desired level.

The type of protection proposed will afford trained personnel, a complete fire detection system, quarters for lookouts and rangers, telephone and radio communications, and fire fighting equipment such as trucks, tractors, fire plows, and hand tools. Since most fires in this watershed are the result of carelessness or incendiarism, a campaign to build up public attitude favorable to fire prevention and control is an essential part of this measure.

Installation of the additional facilities, as recommended herein, will cost about 9.4 cents per acre. Annual cost of operation and maintenance is estimated at 4.5 cents an acre. It is recommended that the Federal Government bear up to half these costs and that the states (with such local and private contributions as may be available) bear the remainder.

Tree Planting for Watershed Restoration

Tree planting is recommended for some 156,600 acres (including 934 acres to be publicly acquired) of poorly protected cropland and pasture to be retired from agriculture; and for some 35,000 acres of understocked forest lands, including about 1,000 acres in existing national forests and 6,000 acres to be acquired1/. Planting is an essential measure in reducing sediment and runoff contribution from these lands.

Recommended species for planting include: white, loblolly, Virginia, and shortleaf pines in the Mountain-Foothills; loblolly and shortleaf pines in the Piedmont; and loblolly, slash, and longleaf in the Coastal Plain. The spacing recommended is 6 x 6 with approximately 1,200 trees per acre to be planted on openland sites and about half that number in the understocked forest land. Such close spacing produces a dense cover and creates favorable hydrologic conditions in a relatively short time.

Currently, tree planting is going forward at a rapid rate in this watershed. Analysis of performance records and other data indicates that nearly half of the planting needs in the watershed will be accomplished under "going" programs during a 15-year period. To accelerate tree planting on the remaining lands, consistent with recommendations herein, it is proposed that the Federal Government bear 35 percent of the planting costs, with states bearing 5 percent, and private interests the remainder. On lands to be acquired the entire cost will be Federal.

1/ Excludes some 38,900 acres of open land and 7,000 acres of private forest land in need of planting, but on which owners are unlikely to maintain adequate forest stands without some form of public control of cutting practices.

Cover Improvement, Private Forest Land

This measure provides for improvement of watershed cover on 3,028,000[1/] acres of private forest land through an expanded program of technical assistance to forest land owners and operators.

About two-thirds of the private forest land is in small, depleted holdings which generally lack management or care and provide little economic return. Owners usually are without forestry skills and lack the resources or incentives to hire technical services of consulting foresters.

Limited technical forestry services are now provided at public expense under a cooperative State-Federal program which needs to be greatly strengthened and expanded. The recommendations provide for a variety of services including preparation of a management plan, advice and assistance in marking timber for cutting in order to maintain good soil and cover conditions; guidance in locating skid trails and roads to minimize erosion and runoff; and aid in harvesting and marketing timber products to enable good management practices.

To meet this need adequately, experienced technical foresters will be employed to work with individual owners in putting their forest lands under management. Each forester will serve about 75,000 acres of forest land. In addition to the on-the-ground services to individuals, he will also cooperate with Extension personnel and others in educational and demonstration work.

The Federal Government will bear up to 50 percent of the cost of this measure with the remainder to be borne by the states.

Public Acquisition

Recommendations provide for public acquisition of about 51,250 acres of Mountain-Foothill land within and contiguous to the Chattahoochee National Forest [2/]. These headwater lands, for the most part, have been heavily cut over and repeatedly burned, and are heavy contributors of sediment and runoff. They will yield little or no returns for several decades and private incentive to manage and give them the kind of care needed to maintain soil stability and build up favorable hydrologic conditions is generally lacking. A first requirement in providing watershed management is to put these lands under stable ownership. It is contemplated that these lands will be added to, and managed as a part of, the Chattahoochee National Forest. Cost of acquisition--all Federal--is estimated at $15.00 per acre including cost of surveys, appraisals, title work, and other expenses.

1/ Excludes some 2,215,000 acres of private holdings which are expected to be managed adequately under present ownerships without public assistance; and some 1,298,000 acres of private forest land which are not expected to be effectively managed without some form of public control of cutting practices.

2/ About 22,750 acres are within the existing unit.

Development and Management of Lands to be Acquired

Public acquisition does not, of itself, improve land or watershed values. To rehabilitate the 51,250 acres scheduled for public purchase will require capital investments and good management over a long period. Recommendations provide for those management activities and development costs which contribute directly to cover improvement.

Needed installations include buildings, and other facilities for forest management and administration 1/. Full account was taken of existing installations on the Chattahoochee National Forest in estimating additional needs. The additional installations will cost an estimated 20 cents an acre. Annual cost of resource management and for maintenance of improvements is estimated at 18 cents per acre.

II. ADDITIONAL MEASURES - SUPPLEMENTAL TO LAND TREATMENT

Stream Channel Improvement and Streambank Stabilization

A survey was made on the sample tributaries of the Apalachicola River Watershed to ascertain the present condition of the tributary stream channels and the kinds and amounts of channel improvement measures which would be effective in alleviating flood damages.

The following sample streams are representative tributaries within the physical land units: The Upper Chattahoochee River above the stream gage at Leaf, Georgia, to represent streams in the Mountain-Foothills area; Sweetwater Creek and the Upper Flint River, to represent streams in the Piedmont Plateau area; and Chipola River and Chickasawhatchee Creek, to represent streams in the Coastal Plain area (figure B-1).

Present Condition of Sample Tributary Streams

The sample stream in the Mountain-Foothills area is fairly stable as to gradient and channel cross section. Some aggradation has taken place in the form of shoals composed of heavy material. The banks and side slopes of the channel are covered with a medium growth of small trees, bushes, and vines.

In the Piedmont Plateau area, the upper reaches of the tributary streams are for the most part partially swamped and filled with sediment. The banks, side slopes, and channels are covered with bushes and small trees. The lower reaches of these streams are only fairly stable with considerable aggradation in some portions. The banks are covered with trees which have shaded out much of the growth which would ordinarily exist on side slopes, and as a consequence, raw banks are frequent.

1/ Fire protection costs are not included here; nor are those for recreation or other developments not related to watershed improvement.

In the Coastal Plain area, most of the tributary streams are shallow and badly swamped, with trees and heavy underbrush growing on the banks, side slopes, and in the channels, which are generally severely aggraded. However, a small number of streams in the better soil areas are better defined, with little channel clogging but with a heavy growth of trees and underbrush on the banks and side slopes.

Recommended Channel Improvement

Channel improvement is recommended for most of the streams in the Mountain-Foothills and the Piedmont Plateau, and for part of the streams in the Coastal Plain. This improvement consists of snagging, removal of logs and debris, and brushing, as well as the removal of trees from stream channels and banks. Logs and brush will be removed from the floodway to avoid future clogging of the channels.

Intermittent dredging and realignment are also recommended for portions of the tributary streams. In addition to other measures, it will be necessary to establish vegetation to stabilize the side slopes of the channels.

Scope of Channel Improvement Operations

The type and amount of channel improvement found beneficial and necessary for the sample tributary streams were expanded to include all the tributary streams in the Mountain-Foothills and Piedmont Plateau Physical Land Units and to selected streams in the Coastal Plain.

Channel improvement consisting of brushing and snagging operations and the establishment and maintenance of suppressive vegetation will be required on all the stream miles considered, along with some dredging and realignment. These improvements will increase channel capacity, reduce flood damages and future maintenance costs. The amount of channel improvement recommended is as follows: Mountain-Foothills, 352 miles; Piedmont Plateau, 4,745 miles; and Coastal Plain, 1,039 miles.

Floodwater Retarding Structures

Investigations made in the sample tributary areas indicate the need for, and the physical and economic feasibility of, installing approximately 1,500 upstream floodwater retarding structures in order to reduce the frequency and severity of floods on good agricultural land. These structures will provide temporary storage of flood water and will be used primarily to protect areas from damage by frequently recurring floods where other measures are impractical or inadequate. A majority of these structures will be within the Piedmont Plateau Physical Land Unit, and drainage areas above them will vary from 600 to 3,000 acres.

The usual structure will be a dam with rolled-earth fill through which a small, low elevation outlet conduit, fitted with a drop-inlet on its upstream end will be constructed for automatic drawdown to the bottom of the flood control pool. The maximum drawdown rate will be held to less than the capacity of the stream channel below the structure.

The volume of storage in each floodwater retarding structure will be sufficient to detain at least three inches of flood runoff from its drainage area. This will be in addition to the runoff discharged through the drawdown conduit during the period of watershed runoff. In addition, conservation storage of not more than 250 acre-feet may be provided for a sediment reserve, livestock water supply, wildlife, and recreational uses.

Side spillways will be provided for discharges in excess of the capacity of the drawdown conduit and reservoir storage. These spillways will be designed to fit the characteristics of the individual site and will meet the essential requirements for safety and economy.

Testing the Effectiveness of the Program

Measurements will be made on a number of selected subwatersheds in areas where runoff conditions are highly critical to determine the quantitative effects of the planned watershed improvement program. Such measurements will be of considerable merit in permitting an evaluation over a period of years of the combined effectiveness of the various measures installed and maintained. The data will also provide the technical base and guide lines for installing the rest of the program and also for determining its most economic operation and maintenance. It is estimated that Federal funds in the amount of $600,000 will be required for installing these stations, including all costs necessary for operation during the installation period of the remedial measures.

ACTIVITIES RELATED TO FLOOD CONTROL

General Statement

Several programs being carried on currently by various Federal and state agencies relate to flood control and have some value in retarding runoff and preventing erosion. Work in the Department of Agriculture related to flood control is carried on primarily by four agencies: Forest Service, Soil Conservation Service, Production and Marketing Administration, and Extension Service.

In developing a recommended program for the Apalachicola River Watershed, it was assumed that "going" programs would continue at present rate of estimated accomplishments.

Department of the Army

The Corps of Engineers has made investigations of the Apalachicola River and its tributaries to determine the feasibility of a comprehensive plan for the development of the water resources. Reports covering navigation, flood control, power development, and irrigation are printed in H. Doc. No. 342, 76th Congr., 1st sess.; H. Doc. No. 300, 80th Cong., 1st sess.; and several prior reports referred to in the above reports. In the first named report, a series of locks and dams with power installation on the Apalachicola and Chattahoochee Rivers to Columbus, and storage dams for flow regulation on the upper Chattahoochee at Roswell, Cedar Creek and Lanier and on the Flint River at Auchumpkee Creek, Potato Creek and Woodbury No. 2 were recommended.

H. Doc. No. 300 provided for higher dams at Jim Woodruff and Upper Columbia to replace five previously authorized locks and dams, Fort Benning lock and dam and the replacement of Roswell by Buford. Recent studies indicate that the three projects on the Flint River will probably be located at different sites before final plans are prepared. Only the Buford and Jim Woodruff sites are now being developed.

The Flint River will have a 9-foot navigable channel to Bainbridge, Georgia, and the Chattahoochee River to Columbus, Georgia, when the presently authorized work is completed.

Private Power Development

The Georgia Power Company has a power dam, Bartletts Ferry, on the Chattahoochee River near Columbus, Georgia, the operation of which contributes to flood control to some extent, since the company on occasion has drawn down the pool in anticipation of high flow during storm periods.

There are many other small developments in the way of small reservoirs for local municipal and private use. However, they are small and do not contribute appreciably to flood control.

Forest Land Management

The U. S. Forest Service manages and protects some 216,000 acres of national forest land within the Chattahoochee and Apalachicola National Forests for watershed protection, timber production, and other purposes. On private lands the Federal and State Governments are cooperating in organized fire control under the Clarke-McNary Act; in the extension of forestry services under the Cooperative Forest Management Act; and in activities relating to the control of forest insects and diseases.

Educational Activities

Federal and State Experiment Stations within or near the watershed supply valuable information and data on measures and practices related to flood control and conservation of watershed lands. The agricultural colleges, vocational agricultural schools, and the U. S. Department of Agriculture Cooperative Extension Service have obtained local recognition of many farm problems and have also rendered valuable assistance by educating the public to appreciate the need for conservation measures.

Direct Aids

The Production and Marketing Administration makes conservation payments and materials available to individual farmers for carrying out soil and water conservation practices, most of which contribute materially in the reduction of flood water and sediment damages.

Soil Conservation Districts

Georgia, Alabama, and Florida have passed enabling acts (Soil Conservation District Laws) under which more than 98 percent of the total

watershed lands are in active soil conservation districts. The U. S. Department of Agriculture cooperates with these districts to the extent of supplying technical assistance through the Soil Conservation Service. The soil and water conservation practices established by these districts are an integral part of a watershed treatment flood control program.

State Highway Departments

The State Highway Departments of Georgia, Alabama, and Florida are aiding in the prevention of sedimentation in many places by stabilizing cut and fill slopes. It is anticipated that no difficulty will be experienced in obtaining their full assistance in carrying out the proposed program.

United States Department of Commerce

The U. S. Weather Bureau has a useful river service, centered at the Atlanta Weather Bureau Office for forecasting gage heights during floods. It is not expected that any changes in this service will be made as a result of the recommended program.

Department of the Interior

The U. S. Geological Survey surface water and ground water divisions maintain and operate gaging and measuring stations, and investigate ground water problems, throughout the watershed in cooperation with state governments and other Federal agencies. Published data thus acquired and data obtained under cooperative agreements are the main sources of stream and ground water information available.

The Fish and Wildlife Service, through its Office of River Basin Studies, under the provisions of Public Law No. 732, conducts surveys and investigations of all Federally sponsored or authorized projects relating to water development.

State fish and game conservation agencies are actively engaged in programs of fish and wildlife habitat improvement, both on specific lands within their immediate jurisdiction and more generally on privately-owned lands in cooperation with other agencies and landowners. Many of the practices advocated for fish and wildlife habitat improvement have some value in prevention of erosion and flood damages. The Dingle and Pittman-Robertson Acts provide Federal aid to states in the development of fish and wildlife resources.

Since the establishment of the recommended measures will modify land use and general environmental conditions, which in turn will influence fish and wildlife resources, close cooperation will be maintained with the Fish and Wildlife Service and State fish and game conservation agencies in the operations stage in order to promote the development of these resources.

Private Interests

District supervisors, technicians, and other agricultural and conservation leaders present at various meetings, and others contacted within the watershed agree that the recommended program is feasible. They are of the opinion that a high percent of the landowners would cooperate if the proposed flood control remedial program is authorized.

Railroad companies have already treated much of their rights-of-way for erosion control, and it is believed that they will cooperate in completing the program.

ANNUAL COST OF "GOING" PROGRAMS

Soil Conservation Service in Cooperation with Soil Conservation Districts

The fiscal year 1950 was used as a base for estimating the annual cost (including administrative and facilitating services) of the Soil Conservation Service assistance to districts. The cost was determined by proportioning total personnel and facilitating costs on a basis of the percentage of watershed farm land in each district. Personnel cost represents salaries paid to local technicians. Facilitating cost represents transportation, office rent, supplies, administrative and technical supervision, and related assistance. The estimated annual cost is $439,300.

Cooperative Extension Service

Correspondence with State Extension Services in Georgia, Alabama, and Florida was used as a basis for estimating accomplishments and costs of this part of the "going" programs within the watershed. A summary of these annual costs follows:

State	Source of Funds		Total
	Federal	State and Local	Expenditure
Georgia	$48,753	$35,431	$84,184
Alabama	5,794	4,371	10,165
Florida	2,212	6,070	8,282
Total	$56,759	$45,872	$102,631

Production and Marketing Administration

As a result of conferences with State Production and Marketing Administration committees in Georgia, Alabama, and Florida, information was supplied on rates of accomplishments and costs of certain measures. This was used as a basis for estimating accomplishments and costs of this part of the "going" programs within the watershed. A summary of annual agricultural conservation program costs (including administrative expenses) follows:

Georgia	$1,826,537
Alabama	279,368
Florida	99,818
Total	$2,205,723

Forest Service

Data furnished by the Forest Service were used to determine the annual costs of the "going" program, as follows:

	Federal	State	Private	Total
Installation Costs	$15,621	$52,434	$170,561	$238,616
Annual Operation and Maintenance Costs	219,375	331,217	16,673	567,265

The total annual federal costs of "going" programs is estimated at $2,936,800.

Table B-1. Land Use Without and With Recommended Program
Showing Net Changes by Physical Land Units
Apalachicola River Watershed

Physical Land Unit		Cropland 1/	Pasture	Perennials 2/	Forest Land	Wildlife	Abandoned Idle	Miscellaneous 3/
		(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Mountain-Foothills	Without Recommended Program	52,391	28,858	11,835	446,471	1,462	2,922	64,061
	With Recommended Program	43,992	34,016	15,930	447,149	2,852	--	64,061
	Net Change	-8,399	+5,158	+4,095	+678	+1,390	-2,922	--
Piedmont Plateau	Without Recommended Program	794,737	444,935	297,549	2,032,381	4,111	35,750	217,737
	With Recommended Program	679,416	497,791	431,547	1,994,054	6,655	--	217,737
	Net Change	-115,321	+52,856	+133,998	- 38,327	+2,544	-35,750	--
Coastal Plain	Without Recommended Program	2,652,154	439,456	98,367	4,464,710	11,571	64,090	461,652
	With Recommended Program	2,485,069	486,362	169,295	4,570,525	19,097	--	461,652
	Net Change	-167,085	+46,906	+70,928	+105,815	+7,526	-64,090	--
Total Watershed	Without Recommended Program	3,499,282	913,249	407,751	6,943,562	17,144	102,762	743,450
	With Recommended Program	3,208,477	1,018,169	616,772	7,011,728	28,604	--	743,450
	Net Change	-290,805	+104,920	+209,021	+68,166	+11,460	-102,762	--

1/ Includes orchards; present acreage also includes cropland idle.
2/ Includes water disposal areas.
3/ Farm homesites, urban areas, roads, streams, etc.

Table B-2. Summary of Watershed Needs and Recommended Program
Apalachicola River Watershed

Measures	Unit	Present Watershed Needs	Recommended Program
I. Land Treatment Measures:			
Subwatershed Waterways	Mile	3,420	3,420
Gully Stabilization and Sediment Control	Mile	18,684	18,684
Erosion Control Along Roads and Railroads	Mile	13,324	13,324
Field Diversions	Mile	20,120	19,390
Terraces	Mile	205,220	132,820
Perennial Vegetation Establishment	Acre 1/	505,050	209,020
Perennial Vegetation Improvement	Acre	111,720	111,720
Pasture Establishment	Acre	349,750	104,920
Pasture Improvement	Acre	668,410	133,680
Wildlife Area Plantings	Acre	22,910	11,460
Farm Waterways	Acre	90,070	63,780
Improved Fire Protection	Acre	7,011,728 2/	6,652,660
Tree Planting for Watershed Restoration	Acre	610,286	191,630
Cover Improvement, Private Forest Land	Acre	4,325,670	3,027,670
Public Acquisition	Acre	51,250	51,250
Development and Management of Lands to be Acquired	Acre	51,250	51,250
II. Additional Measures:			
Stream Channel Improvement & Streambank Stabilization	Mile	6,136	6,136
Floodwater Retarding Structures	Number	1,500	1,500

1/ Includes farm waterway acreage.
2/ Includes forest on military reservations (139,220 ac.)

FIGURE B-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M. SALTER, CHIEF
SOUTHEASTERN REGION
T. S. BUIE, REGIONAL DIRECTOR

SAMPLE TRIBUTARIES
APALACHICOLA RIVER WATERSHED
IN
ALABAMA, FLORIDA, AND GEORGIA

10 0 10 20 30 40 MILES

REV. 11 30 51

APPENDIX C

HYDROLOGY

PROCEDURES FOR CALCULATING FLOOD REDUCTIONS

Hydrologic investigations were made to determine the flood reductions which might reasonably be expected as a result of the recommended program. The determination of present and future damages and benefits (before and after the program) was in general made separately for the tributaries and for the reaches of the main streams of the Apalachicola River. The hydrologic investigations followed the same breakdown, but much the larger part of the work was done on the tributary investigations since the greater part of the benefits is to be expected from the recommended program on the tributary areas.

Basic data, computations, analyses, and detailed information used in developing the hydrology appendix are available in the files of the Soil Conservation Service Washington office or the Southeastern Regional office. References to "the files" in what follows mean to the files at these places.

TRIBUTARIES

The Apalachicola River drainage area was divided into "Physical Land Units" which, under similar cover and treatment, produce fairly uniform runoff, sediment, and deterioration of soil resources. The investigation was made by means of sample tributaries, data from these samples being expanded to give the results for the physical land units. See Appendix D for details regarding the methods of expansion used.

The sample tributaries used in the hydrology investigation were the upper Chattahoochee River and Sweetwater Creek. These are described below.

Description of the Sample Tributaries

1. Chattahoochee River above the gage near Leaf, Georgia, was selected to represent the tributaries in the Mountain-Foothills Physical Land Unit. This sample tributary has a drainage area of 150 square miles. It is roughly oval in shape, about 19 miles north and south by about 13 miles east and west. The gage is at the southern end.

The watershed lies from about 1,220 feet to about 2,000 feet above sea level, with a considerable area above 1,500 feet as the stream profile itself rises above this elevation. The zero of the gage is at 1,219.5 feet above sea level. The lower fifty percent of the stream length has an average grade of about 9 feet per mile. The middle twenty percent has a grade of about 18 feet per mile, while the headwaters are considerably steeper, averaging about 36 feet per mile.

The drainage pattern above the gage is dendritic. The main stream flows through the approximate center of the drainage area, with the tributaries on either side about equal in size and spacing.

2. Sweetwater Creek above the gage near Austell, Georgia, was selected to represent the tributaries in the Piedmont Plateau Physical Land Unit. This is a moderately large sample tributary, with a drainage area of 246 square miles. It is approximately rectangular in shape, about 23 miles east and west by about 12 miles north and south. The gage is at the southeastern corner.

The watershed lies from about 860 feet to about 1,500 feet above sea level, much of it being above 1,000 feet. The zero of the gage is at 857.0 feet. The lower sixty percent of the main stream is flat with an average grade of only 2 feet per mile. The middle twenty-five percent has a grade of about 7 feet per mile. The upper portion is very much steeper, with grades from 40 feet per mile to over 60 feet per mile on the headwaters.

The drainage pattern above the gage is approximately fan-shaped. The main stream flows east along the southern part of the drainage area. The large tributaries which form the fan-shaped drainage pattern flow from the north and northwest, entering the main stream only a few miles above the gage.

Precipitation and Streamflow Data: Availability and Average Values

Long-term records of daily rainfall from standard U. S. Weather Bureau non-recording gages were reasonably plentiful over the Apalachicola River Watershed as a whole. However, precipitation records for use in the analysis of the sample tributaries were inadequate for at least part of the period of record, and required adjustment to give consistent results. No stations except some recently established ones were within the sample tributary areas, although a number of long-term stations were close enough to give approximate rainfall, especially for the general-area flood-producing storms. (See "Rainfall versus Runoff and Peak Stage Relations" for more details.)

Average annual rainfall over the watershed as a whole is about 51.5 inches. Average annual rainfall over the Mountain-Foothills Physical Land Unit is high, being about 60 inches. In the Piedmont Plateau the average drops to approximately 50 inches, increasing somewhat to between 50.5 and 51 for the Coastal Plain.

Stations with a record of over fifty years are:

Albany, Georgia (67 years, 49.29 inches),
Americus, Georgia (67 years, 49.09 inches),
Atlanta, Georgia (82 years, 48.27 inches),
Bainbridge, Georgia (68 years, 50.28 inches),
Blakely, Georgia (69 years, 55.11 inches),
Columbus, Georgia (60 years, 49.46 inches),
Dahlonega, Georgia (59 years, 61.10 inches),
Eufaula, Alabama (66 years, 52.72 inches),
Fort Gaines, Georgia (67 years, 51.50 inches),

Gainesville, Georgia (76 years, 54.59 inches),
Newnan, Georgia (67 years, 51.99 inches),
Talbotton, Georgia (57 years, 50.57 inches),
West Point, Georgia (67 years, 52.20 inches),

See Figure C-1 for the locations of these stations.

Intensity of precipitation records were available for Atlanta, Georgia. Since this station is located reasonably close to the two sample tributaries, it was used for the analysis needed in applying the infiltration formula. See "Analysis of Intensity of Precipitation Records".

Streamflow records of reasonable length were in general available where needed. See "The Evaluation Series of Floods". Published records of the United States Geological Survey were used, so far as available, in the analysis of runoff on the sample tributaries. For the last one or two years of the analysis, use was made of unpublished runoff data obtained through the cooperation of the U. S. Geological Survey.

Average annual runoff is about 17 inches over the larger part of the Apalachicola River Watershed. This increases somewhat in the lower part of the Coastal Plain. It also increases considerably in the Mountain-Foothills Physical Land Unit. See the U. S. Geological Survey publication: "Annual Runoff in the United States" (Circular 52, 1949).

Outline of the Procedure for Evaluating the Recommended Program

The major phases of the procedure used to evaluate the effect of the recommended program on each sample tributary and to expand these data to the physical land units are briefly outlined below.

1. Rainfall (P) versus volume of storm runoff (Y) relations were developed for each sample tributary using actual streamflow and precipitation records.

2. An evaluation series of floods was developed for each sample tributary.

3. The effect of infiltration into the soil both before and after the proposed land use program, was determined by a simplified method using an empirical formula. Local soil, cover, and hydrologic conditions were taken into account by the use of special coefficients in the general formula. The major steps used in the application of the formula are:

a. Use was made of an analysis of the best available record from a recording gage (intensity of precipitation data), typical so far as possible of the watershed as a whole.

b. The soils in the watershed were classified as to texture. The area of each texture group was determined for each physical land unit and each sample tributary.

c. Cover conditions were classified in accordance with the classification set up by the coefficients used in the infiltration formula. This in combination with the soil texture classification of (b) above gives the evaluation classes used in this phase of the investigation.

d. The area of each evaluation class in each sample tributary was determined and listed for both present conditions and future conditions (after land treatment measures have been applied).

e. An index (θ) was computed for each evaluation class in each sample tributary using the infiltration formula and the average rainfall versus runoff relation of 1 above. This index, expressed in inches per hour, is the average infiltration rate for the evaluation class and its value is adjusted to conform to the measured (average) P versus Y relation.

f. With these θ values and the area of each evaluation class (present and future) computed storm runoffs (P_e) were determined for each evaluation class and for the whole sample tributary for each of the selected "design storms". This gave average P versus P_e relations for the sample tributary for both present and future conditions.

4. Studies were made of all floods in the evaluation series to determine the reduction in peak gage heights that would result from channel improvement.

5. Peak stages for future conditions were determined. See "Effect of the Recommended Program on Flood Reductions".

6. The areas inundated by a flood of a given peak gage height (from "bankfull stage" to the highest peak considered possible) were determined from actual engineering field surveys combined with a stereoscopic study of the corresponding aerial maps. This information was needed to estimate the flood damages over the period covered by the evaluation series of floods.

Each of the steps in the above list is discussed in the following sections.

Rainfall versus Runoff Relations

A rainfall versus runoff relation was developed for each sample tributary using all available streamflow and precipitation data.

Depth of rainfall (P) for each storm was computed using the Horton-Thiessen method for determining the weights of the recorded precipitation. (See table C-1 for the precipitation stations and weights used.) When "antecedent rainfall" was appreciable it was considered, the actual storm rainfall being corrected by adding an "index of antecedent rain". The index used was one of the customary ones defined by:

$$\text{Index} = P_1/1 \quad P_2/2 \quad P_3/3 \quad \ldots \quad P_{10}/10,$$

where P_1 is the rain, in inches, falling on the day preceding the first day of the storm rainfall, P_2 the rain falling during the second preceding day, etc.

Total discharge (volume) was computed using the observed discharge hydrographs for the storm period as plotted from streamflow data. Ground-water inflow into the stream was determined by a simplified method based on the ground-water depletion curve. Total discharge (volume) during the flood period, less the volume of ground-water inflow, gave the "storm discharge" (Y). These computations were made for each storm occurring in the evaluation series, whenever data were available. The results for each sample tributary were plotted as a "scatter diagram" and an average P versus Y relation for the sample determined graphically from this diagram. Seasonal relations were not used, one curve (relation) only being determined for each sample tributary. Past experience in similar watersheds with a seasonal breakdown has not been satisfactory. Seasonal differences in the P versus Y relations apparently occur, but they are neither large enough nor consistent enough to be useful.

Average "Peak Stage versus Precipitation" curves were developed for later use in determining flood damages. The peak stage for each significant storm was plotted against the precipitation causing the stream rise and an average curve drawn. From this average Peak Stage versus Precipitation curve and the average P versus Y curve, an average "Peak Stage versus Y" curve can be determined whenever needed. This was done in preliminary studies, but the curve was not used in the final study of the evaluation series. The average Peak Stage versus Precipitation curve for conditions after channel improvement was determined from the above curves and from the channel improvement studies.

The average P versus Y curves for the two sample tributaries are shown in figures C-2 and C-3. The Peak Stage versus Precipitation curves are shown in figures C-4 and C-5.

The Evaluation Series of Floods

1. Chattahoochee River. The actual series of floods recorded at the gage on the Chattahoochee River near Leaf, Georgia, for the 10-year available record (March 1, 1940 to February 28, 1950) was used as the evaluation series of flood events. During this period 41 rises occurred; these were analyzed for use in the P versus Y relation. Not all of these 41 rises caused appreciable out-of-bank

flow and hence flood damage. "Bankfull stage" occurs at about 6.0 feet (gage reading). This corresponds approximately to the average rise caused by a 2.3-inch rainfall. Table C-2 lists the 35 rises causing appreciable inundation during this 10-year period, and tabulates precipitation, average present and future runoff and average present and future peak stages.

2. Sweetwater Creek. The actual series of floods recorded at the gage on Sweetwater Creek near Austell, Georgia, for the 13-year available record (March 1, 1937 to February 28, 1950) was used as the evaluation series of flood events. During this period, 46 rises occurred; these were analyzed for use in the P versus Y relation. However, not all of these caused appreciable out-of-bank flow and hence flood damage. "Bankfull stage" occurs at about 8.0 feet (gage reading). This corresponds approximately to the average rise caused by a 2.1-inch rainfall. Table C-3 lists the 34 rises causing appreciable inundation during this 13-year period, and tabulates precipitation, average present and future flood runoff and average present and future peak stages.

Development of Infiltration Data

The Infiltration Formula - Infiltration data from the entire United States have been collected and analyzed by the Soil Conservation Service Washington office. The result has been condensed into an empirical formula, in two parts, which simplifies the application of the data to actual cases and thus gives a simplified method to determine the effect of improved soil and cover conditions on runoff. The formula is:

$$\theta = C\,[.178 + (S+k)] - .178, \text{ when } S + k > .20;$$
$$\theta = C\,[.604 + (S+k)] - .604, \text{ when } S + k < .20,$$

The symbols have the following meanings.

The coefficient S was introduced into the formula to measure the effect of the soil on the infiltration rate, using soil texture as the criterion. (See "Soil Classification".)

The coefficient C measures the effect of cover conditions on the runoff. (See "Cover Conditions: Evaluation Classes".)

The watershed coefficient (correction factor) k and the infiltration rate θ are explained under the heading: "Computation of the Index θ".

Detailed explanations and computations are not given here since they are available in the files. However, the sections immediately following give the methodology especially applicable to this report.

Analysis of Intensity of Precipitation Records - Use of the infiltration theory (either by an empirical formula or by direct analysis) requires the preparation of an average "dimensionless diagram"

for one or more stations which can be considered representative of the area under consideration. The preparation of such a dimensionless diagram requires intensity-of-precipitation records for 5-minute intervals over a reasonably long period of record (about ten years for representative results). As remarked previously under "Precipitation and Streamflow Data" these intensity data are available for Atlanta, Georgia.

The Horton-Thiessen polygon for the Atlanta gage is partly within the Apalachicola River Watershed, and Atlanta is one of the precipitation stations actually used in the analysis of the Sweetwater Creek sample tributary. The Atlanta station is also reasonably close to the Chattahoochee River sample tributary. Due to this unusually favorable location and because the Atlanta climate is reasonably typical of the general Apalachicola River climate, the dimensionless diagram for Atlanta was selected for use in this survey.

The Atlanta records were analyzed during the survey of the Coosa River above Rome, Georgia. At the same time, an analysis was made of a similar ten-year rainfall record for Chattanooga, Tennessee. The final dimensionless diagrams for the two analyses were so nearly the same that they were combined into a composite diagram, which is used also in this survey. See figure C-6.

The analysis of the storms at Atlanta and Chattanooga gave the values:

I_{max} = 1.60 inches per hour for P = 1.50 inches,

I_{max} = 2.05 inches per hour for P = 3.00 inches,

I_{max} = 2.50 inches per hour for P = 4.50 inches.

Values of I_{max} for other precipitations are approximately proportional to these.

From the dimensionless diagram and the I_{max} values, the "P_e curves" or "Rainfall Excess Graphs" for each of the three selected design storms were computed and plotted. (See figure C-7). Their construction and use are explained in discussions in the files.

Soil Classification - A classification with respect to texture was made of the soils in the watershed. Texture, as used here, is defined as the relative proportion of the three principal size groups (sand, silt, and clay) occurring in the soil. The textural groups are based on field determination and/or mechanical analysis of the sand, silt, and clay fractions. This is taken from tabulated data, published or unpublished, for areas where soil surveys have been made. This classification is solely for use in the infiltration formula, and may group soils not similar in other respects. The extent of distribution of each group was based on measured soil conservation surveys or other types of measured soil surveys.

The distribution of the textural groups with respect to cover conditions is discussed under "Cover Conditions, Evaluation Classes" and "Areas of Evaluation Classes in each Sample Tributary".

The following table shows the soil classification used in the Apalachicola River survey.

Soil Classification as to Texture (for use in the Infiltration Formula)

Physical Land Unit and Soils	Area in Sample Tributary (sq. mi.)	Average Texture		
		% of Sand	% of Silt	% of Clay
Mountain-Foothills				
Loams	61.0	43	43	14
Sandy Loams	70.3	65	25	10
Clay Loams and Clays	18.7	35	35	30
Piedmont Plateau:				
Loams	8.3	43	43	14
Sandy Loams	126.2	65	25	10
Clay Loams and Clays	111.5	35	35	30

A value of the coefficient S of the infiltration formula corresponds to each set of the three percentages which define the texture of a given soil. This value S is found by using a triangular chart which is in effect a part of the infiltration formula. This chart is available in the files.

For the three textures in the above table, the values of S are 0.447, 0.621, and 0.251, respectively.

Cover Conditions, Evaluation Classes - A cover condition classification for hydrologic use is required for the infiltration formula. This formula contains a cover coefficient ("factor of cover") C, which varies with the cover. The cover classification need not be a very detailed one for present purposes; hence it groups some of the individual cover classes used in planning the land treatment program.

See the section: "Forest Hydrologic Conditions" for the methods used in determining woodland cover conditions.

The values of the "cover coefficient" C, for the cover conditions occurring in the watershed, are as follows:

Values of Cover Coefficient C

Cover Description	C	
	$S + k < .20$	$S + k > .20$
Row Crops* and Miscellaneous	1.00	1.000
Poor Pasture and Poor Abandoned	1.02	1.042
Poor Woods	1.04	1.094
Small Grain and Good Abandoned	1.09	1.185
Close Growing, Poor Kudzu and Sericea	1.17	1.360
Good Pasture, Good Alfalfa, Med. Woods	1.25	1.541
Good Woods, Good Kudzu	1.36	1.770

*Row crops are in this first (poorest) class for present conditions. For future conditions, row crops are classed with poor pasture, etc., as the improved practices recommended in the land treatment measures should also increase the average infiltration rates for land in row crops.

Each of the seven cover types, combined with a soil texture group, gives an evaluation class corresponding to the "Soil-cover Complex" used in the analysis of infiltration data.

Areas of Evaluation Classes in each Sample Tributary - These areas were determined for each sample tributary to which the infiltration formula was applied and for the corresponding physical land unit. The areas were taken from the tables used in planning land treatment measures and regrouped according to the hydrologic "evaluation classes". Detailed tables showing the computations and grouping are available in the files.

The stream discharges (which are known for the period of record) are those discharges coming from the actual distribution of cover conditions during this period. In order to make measured flood discharges and present "evaluation class" areas comparable, these areas for the sample tributaries were taken as the actual present areas within the sample watershed. The present cover distribution (for sample tributaries and for the physical land units) was based on soil conservation surveys, soil conservation district reports, and the U. S. Census of Agriculture. Field investigations showed that no extensive changes in general land use practices have occurred within the period of record of the stream gages used. Thus the present distributions and areas of the evaluation classes give an approximately true picture for the whole period of record.

Future cover conditions, after the remedial program is in full effect, were based on the best conservation measures for the land as indicated by the land use capabilities and economic factors involved. This was done on a physical land unit basis, and the areas thus obtained were scaled down proportionally to give the future evaluation class areas for the corresponding sample tributary. If a sample

tributary represented its physical land unit exactly in all respects, the present and future areas as found by the above procedures would be exactly comparable. In practice there is always some lack of agreement, but the sample tributaries for this survey are reasonably representative as regards these phases of the investigation. Taking into account the methods of expansion used in the economic portions of the survey, no serious error results from this source.

Computation of the Index θ - A value of C and of S was determined for each evaluation class as previously explained. A series of trial computations by the infiltration formula was next made to determine the "watershed correction factor" k and the corresponding values of θ in each case. Trial computations were continued until the values of θ thus found would give a storm runoff equal to the average storm runoff actually obtained in the precipitation versus runoff investigation previously described.

Computation of Storm Runoff, Present and Future - The areas of the evaluation classes will in general be different under present and future conditions. It was assumed that for a particular evaluation class approximately the same hydrologic and climatic conditions will hold in the future as at present. Thus the hydrologic changes in the watershed due to the recommended land use program are caused mainly by the changes in the areas of the evaluation classes. On this account the same k and θ values were used for both present and future computations and for all design storms. The results for the present, of course, agree closely with the average P versus Y relation previously obtained, since the watershed correction factor k was selected to satisfy this average relation.

Detailed computations for P_e, present and future, are in the files. (P_e as used here, is the amount of "rainfall excess" measured in inches, and hence the approximate storm runoff). See figure C-2 for the results of the storm runoff computations for the Chattahoochee River sample tributary, and figure C-3 for the Sweetwater Creek results.

The use of the infiltration formula automatically makes the computed P versus P_e (P versus Y) relation for present conditions the same as the average P versus Y relation obtained from the analysis of the rainfall-runoff data.

This would, in general, still be true if the formula were applied directly to a watershed having an appreciable amount of "quick return flow" ("subsurface runoff") coming from areas with shallow profile soils.

Surface runoff is determined from infiltration data when subsurface runoff is not present, but if such subsurface runoff occurs, it must be evaluated independently before surface runoff can be known. There are areas of thin profile soils in the watershed and some subsurface flow is undoubtedly present in the storm runoff. However, in determining future runoff, the proportion of subsurface flow does not

appear large enough to require modification of the direct application of the infiltration theory.

Results from the P versus Y investigation for the sample tributaries confirm the above conclusion. The table following gives average observed Y values for a four-inch rain for various tributary watersheds. Since the P versus Y average curves are approximately similar in shape for streams in this locality, the average Y value for a single heavy rainfall is sufficient to give comparative results.

Average Storm Runoff (Y) Values for a 4-inch Rain

Tributary	Physical Land Unit	Y (inches) for P = 4.00 in.
Apalachicola River		
Chattahoochee River	Mountain-Foothills	1.57
Sweetwater Creek	Piedmont Plateau	1.68
Savannah River		
Keowee River	Mountain-Foothills	1.33
Broad River	Piedmont Plateau	1.27
Little River (S.C.)	Piedmont Plateau	1.72
Pee Dee River		
Fisher River	Mountain-Foothills	2.15
Third Creek	Piedmont Plateau	1.25
Roanoke River		
Upper Roanoke	Limestone Valley	1.65
Blackwater River	Mountain-Foothills	1.33
Sandy River	Piedmont Plateau	1.60
Falling River	Piedmont Plateau	1.25

Fisher River is known to have considerable quick return flow. The other streams listed above in the Savannah, Pee Dee, and Roanoke Rivers are known to have no significant quick return flow. The values of Y in the table indicate that quick return flow in large amounts does not occur on either of the sample tributaries of the Apalachicola River Watershed.

Forest Hydrologic Conditions, Present and Future

Present - Forest floor conditions are a good index of the ability of forest land to absorb and retain rainfall. Field surveys show that the typical forest floor in the Apalachicola Watershed consists of a sparse, poorly distributed layer of litter over a thin, poorly incorporated layer of humus. While there are limited areas with adequate watershed cover, the major part of forest land is in unsatisfactory condition for watershed purposes because of woods fires,

destructive cutting and logging practices, and unregulated grazing. At present 73 percent of the forest land area is classed as poor from the standpoint of runoff retardation.

In the Mountain-Foothills, where fire records indicate a relatively low annual burn and grazing is naturally limited by the terrain, watershed conditions are generally superior to those in the Piedmont and Coastal Plain. National forest lands, where grazing and cutting are regulated and fire protection of a high order is provided, are in better condition than the private lands, most of which lack purposeful care or management.

Future - With the recommended program fully effective, there will be a great improvement in the hydrologic condition of forest lands in the watershed. With harmful factors such as overgrazing, burning, and improper cutting greatly reduced, an adequate watershed cover will be developed on a large proportion of these lands. The protection afforded will not be equal to that provided by an undisturbed virgin forest, but will be at least equivalent to that classed in this report as good at the present time.

It is not expected, however, that all forest lands will develop good cover as a result of the program. Some damage to watershed values is inevitable under even the most intensive restoration program, if the economic contributions from the forest are to be realized. Furthermore, a certain minimum of damage from burning is to be expected since no protection system can completely eliminate forest fires. Nor is it to be expected that forestlands on flood plains subject to overflow will improve in their cover conditions. In recognition of such factors, estimates were prepared of the acreage of forest land in each physical land unit which would attain good, fair, and poor condition in the future with the program fully effective.

Channel Improvement

Reconnaissance showed that it would in general be beneficial in the watershed to perform simple channel improvement work such as clearing and removing debris, intermittent enlarging and straightening of channels, and establishing suppressive and protective vegetation on the banks of streams. An investigation was therefore made to determine the effect of such measures from the hydrologic standpoint. These hydrologic effects were then used as part of the data required for an economic investigation of the effect of channel improvement.

Standard methods were used in this investigation. Approximate gage height versus discharge curves (rating curves), for present conditions and for the future conditions after channel improvement, were determined at one or more cross-sections of the stream. The reduction in gage height, for a given discharge, due to the channel improvement, was then found from these curves.

Field work determined the values of the water-surface slope "s" at the selected cross-sections, the cross-sections themselves, and notes about conditions affecting the present value of "n" (the"coefficient of roughness" in Manning's formula). "Slope-area" computations by Manning's formula using this present value of n, gave the present rating curve. As a check on the estimated value of present n and on the computed rating curve, a preliminary computation was made in each case for the cross-section at the stream gage. Here an accurate rating curve was available from U. S. Geological Survey records; with this rating curve and the measured water-surface slope and cross-section, the values of n can be determined which, when substituted in Manning's formula, will reproduce the rating curve. When the cross-section at the stream gage seemed to be representative of the general valley conditions in the stream, this cross-section was given major weight in the investigation because of its known present rating curve. When the gage cross-section was not representative for any reason, one or more other cross-sections were also investigated and the results considered in determining the final rating curves for present and future.

For conditions after channel improvement, the same slope s and the same cross-section values were used as for present conditions. New values of n were used for the future channel section, however. These values of n were estimated after a study of probable future conditions on the stream under investigation. Investigations of the effect of channel improvement, with computations for n before and after the improvement, have been made at various times on streams comparable to those in the Apalachicola River Watershed. These investigations were also considered in selecting values of n for future conditions. Improvement in the overflow section (flood plain) sufficient to make an appreciable change in n is not contemplated as a channel improvement measure. Consequently, the values of n used for the overflow section were taken the same for the future as for the present.

Present and future average rating curves for the Chattahoochee River sample tributary are shown in figure C-8. Field observations showed that the channel is at present much interrupted by growth. The present value of n is therefore unusually high, averaging about 0.078 for the range of gage heights within which flood damage reductions may be expected. Computations at the gage section confirmed this average value. Future values of n were estimated to average about 0.058 through the same range of gage heights. The possibility of great improvement in channel conditions in the Mountain-Foothills accounts for the comparatively large change in the value of n. Maintenance charges are provided for in the program.

Average rating curves for the Sweetwater Creek sample tributary are shown in figure C-9. Present values of n for the channel section averaged about 0.061, and future values were assumed to average about 0.049.

In making the general estimates given above for the hydraulic effects of channel improvement, consideration was given to the fact that, before these measures are actually put into effect, detailed flood routing studies will be made to determine the specific location and timing of such contemplated measures.

The "Peak Stage versus Precipitation" curves for the Chattahoochee River (figure C-4) include a curve for conditions "after channel improvement and after land program." This "after channel improvement" curve is determined from the "after land program only" curve of figure C-4 and the Chattahoochee River rating curves of figure C-8, under the assumption that in general the land improvement program will probably go into effect first. The similar curve for Sweetwater Creek is shown in figure C-5.

Floodwater Retarding Structures

An engineering and economic investigation was made of the feasibility of floodwater retarding structures in the upper tributaries of the Sweetwater Creek sample watershed. As a part of this, a hydrologic investigation was made of the flood peaks to be expected at the site of the projected structures. Field work had already determined the elevations above mean sea level of the approximate bankfull stage, and of the flood marks for the January 1946 and the November 1948 floods. With these three elevations and the corresponding three readings of the gage it was possible to construct an approximate curve showing the relation between gage readings and the flood heights at each structure under consideration. (For this watershed these were approximately straight-line relationships.) By combining the evaluation series of floods of table C-3 (for Sweetwater Creek) and the relationship just described, an evaluation series of gage heights was made for floods near the site of the structure. These were used in the economic investigation to determine approximate average annual benefits due to the projected structure.

Effect of the Recommended Program on Flood Reductions

The present and future average P versus P_e (P versus Y) relations, found for each sample tributary, were used to determine the hydrologic effect of the recommended land use measures. These P versus P_e relations were assumed to apply in general to the physical land unit represented by the sample. Thus, figure C-2 gives the curves (relations) used for both the Chattahoochee River sample tributary and for all the tributaries in the Mountain-Foothills Physical Land Unit.

The future Y and Peak Stage values of table C-2 (and C-3) were found from the present values and the curves of figure C-2 (and C-3) and figure C-4 (and C-5).

The percentage reductions in the storm runoff Y due to the recommended land treatment program are shown in figure C-12 and figure C-13.

The gage height percentage reductions (in terms of present gage heights, before land treatment and before channel improvement) due to the land treatment measures only are shown in figure C-14 for the Chattahoochee River. Also figure C-14 shows the percentage reductions (in terms of the same present gage heights) due to the effect of channel improvement superimposed on the reduced flood peaks after the land treatment measures have been carried out. The corresponding percentage reductions for Sweetwater Creek are shown in figure C-15.

Stage versus Area Inundated

The area inundated for various flood stages (gage heights on the gage of the sample tributary) was determined for each sample tributary and the physical land unit it represents as outlined below.

1. A field survey obtained as many sections of the mean low-water profile of the stream as were needed for the purposes of the survey, referencing them to the zero of the gage and to mean sea level. Representative valley and channel cross-sections were obtained at the same time, located to give a reasonable coverage showing average conditions. This profile (or separate sections of the profile) and the series of cross-sections covered the length of the sample tributary from the gage to a point above which inundation is not significant. The profile and cross-sections were plotted to scale.

2. High water marks of historic floods at various points were determined by field investigation and referenced to the zero of the gage. Field work was concentrated on two selected floods of fairly recent date having flood crests different enough to give two maximum flood crest lines reasonably far apart on the flood plain.

3. The high water marks were plotted on the aerial photographs and their elevations indicated. Profile elevations were located on the photographs, and also the cross-sections to scale, with elevations indicated. Any other points whose locations and elevations were known were also plotted on the photographs.

4. With the aid of these plotted points, the line of maximum inundation (boundary of the area of inundation) was drawn on the aerial photographs by stereoscopic methods, for each of the two selected floods. This line of maximum inundation (maximum crest line) of a flood is not a contour line, but, in general, it is sufficiently near level so that a stereoscope can be used.

5. The area inundated by each of the two selected floods was then planimetered directly from the aerial photographs. Reaches of the stream were used, for convenience, based on the surveyed cross-sections and on intermediate cross-section lines located approximately on the photographs.

6. Areas inundated by floods intermediate between the two selected floods and by floods greater or less than these two were found (by reaches) by an approximate formula. This formula assumes that for a given stage the ratio of the area inundated at that stage, to the planimetered maximum area inundated for a given reach, is proportional to the ratio of the sum of the widths of inundation for the given stage to the sum of the widths of inundation for the maximum flood, the end sections of the reach being used for these widths. For assumed gage heights below or nearer the lower of the two selected floods, data from this lower flood were used instead of from the maximum flood. Since this area of inundation formula is approximate, results from it were examined for reasonableness and checks made if necessary, even to the extent of considering "concordant flow" at a cross-section when simpler methods did not decide the question.

7. The total area thus found was corrected to give open land only, and was expressed as "average area of inundated open land per mile of stream." The results were tabulated and, in combination with present and future gage heights (as listed in tables C-2 and C-3) and flood damage estimates on an areal basis, were used to compute damage and benefit figures. The data from these area-inundated tables are plotted to give figures C-10 and C-11.

Stage versus Duration of Inundation

Since in many cases the damage caused by flood inundation is clearly dependent upon the duration of time the fields are under water, it was necessary to consider duration of inundation. A study of the duration of inundation computed for each storm on the tributaries of the Coosa River above Rome, Georgia, showed that there was no significant relationship, from the standpoint of damage, between flood heights (only) and duration of inundation. Different floods, of course, result in different durations of inundation, but gage height or depth of flooding alone does not determine the average duration. Hence the survey party handled this phase of the investigation by methods not depending on a hydrologic investigation.

For many storms the duration of inundation for the various depths of inundation (in physical land units other than the Coastal Plain) was about one-quarter day for depths of 1 and 2 feet, and one-half day for depths of 3 and 4 feet. But individual storms showed considerable variation even from this approximate figure.

MAIN STREAMS

Investigations made during the survey on the probable damage reductions to be expected on the main streams, from the measures recommended in the report, indicated that a detailed procedure (tying in the damages and the benefits to actual flood heights on the main streams) was not advisable. Probable total damage reductions on the main streams were not great enough to warrant such a detailed procedure in this survey.

Where damage reductions on main streams seemed to have a possibility of being appreciable, these conditions were in the upper reaches of the main stream sections. Damages and benefits could thus be investigated as part of the tributary investigation, modified for the changed conditions. Reductions obtained in this way could be checked for reasonableness, since enough data have been accumulated in previous surveys to give an approximate relation between tributary damage reductions and main stream reductions.

See Appendix D for a more detailed discussion.

HYDROLOGIC DATA

There is a deficiency of hydrologic data on small watersheds that are most likely to be of value to future reports and to subsequent operations on upstream flood control projects. When authorization is obtained for works of improvement, provision should be made to obtain satisfactory hydrologic information on small watersheds.

Table C-1..-Horton-Thiessen weights for the sample tributaries
(percent of the tributary watershed area within
the precipitation polygon)
Apalachicola River Watershed

Tributary	Period during which the given weights were used (inclusive)	Precipitation Stations (Georgia)												
		Blairsville	Brasstown Bald	Burton Dam	Clayton	Clermont	Cornelia	Neel Gap	Atlanta	Douglasville	Embry	Tallapoosa	Taylorsville	Woodstock
Chattahoochee R.	Feb.-July, 1940	40	-	-	10	-	50	-	-	-	-	-	-	-
	Aug. 1940 to Dec. 1941	40	-	-	10	15	35	-	-	-	-	-	-	-
	1942 - 1947	30	-	50	-	10	10	-	-	-	-	-	-	-
	1948, 1949	-	20	30	-	5	10	35	-	-	-	-	-	-
Sweetwater Creek	Mar.-Dec. 1937 Jan.,Feb. 1939	-	-	-	-	-	-	-	70	-	-	30	-	-
	1938 1939 (most) Jan.-June 1940	-	-	-	-	-	-	-	45	-	-	20	25	10
	March 1939	-	-	-	-	-	-	-	55	-	-	30	-	15
	July-Dec. 1940 1941-1944 1945 (most) 1946, 1947 1948-49 (most)	-	-	-	-	-	-	-	-	60	25	-	10	5
	Dec. 1945 Apr. 8-30, 1948	-	-	-	-	-	-	-	-	70	25	-	-	5

Table C-2..-Evaluation series of floods which caused appreciable inundation Chattahoochee River sample tributary Apalachicola River Watershed

Basic Defining Data of Flood		Present		Future			
		Average results corresponding to given precipitation		After Land Program Only		After Land Program and Channel Improvement	
Date	1/ Precipitation P	Runoff Y	Peak Stage	Average Y	Avg. Peak Stage	Avg. Peak Stage	Total percent reduction in stage
	(in.)	(in.)	(ft.)	(in.)	(ft.)	(ft.)	
8/13/40	6.30	3.12	11.8	2.88	11.4	10.2	13.4
8/29/40	3.80	1.45	8.5	1.23	7.8	6.2	27.1
7/5/41	4.59	1.90	9.6	1.68	9.0	7.45	22.4
2/16/42	5.37	2.41	10.7	2.17	10.2	8.8	17.8
3/21/42	2.95	1.02	7.2	.82	6.35	4.8	33.3
9/27/42	3.60	1.34	8.2	1.12	7.5	5.9	28.0
12/29/42	5.00	2.16	10.2	1.93	9.65	8.2	19.6
1/19/43	2.61	.88	6.6	.69	5.7	4.1	37.8
2/4/43	2.55	.85	6.5	.66	5.6	4.0	38.5
3/21/43	2.45	.81	6.3	.62	5.4	3.8	39.7
4/19/43	2.95	1.02	7.2	.82	6.35	4.8	33.3
7/26/43	3.20	1.14	7.6	.93	6.8	5.2	31.6
3/19/44	4.44	1.80	9.4	1.58	8.8	7.2	23.4
3/29/44	3.20	1.14	7.6	.93	6.8	5.2	31.6
9/14/45	2.50	.84	6.4	.65	5.5	3.9	39.0
9/16/45	2.45	.81	6.3	.62	5.4	3.8	39.7
12/25/45	2.55	.85	6.5	.66	5.6	4.0	38.5
1/7/46	8.20	4.78	13.6	4.55	13.35	12.6	7.5
1/31/46	2.50	.84	6.4	.65	5.5	3.9	39.0
2/10/46	6.10	2.96	11.6	2.71	11.2	10.0	13.8
3/8/46	3.33	1.20	7.8	.99	7.0	5.4	30.8
3/29/46	4.02	1.56	8.8	1.34	8.2	6.6	25.0
1/20/47	4.70	1.96	9.8	1.74	9.2	7.65	21.9
2/12/48	2.95	1.02	7.2	.82	6.35	4.8	33.3
3/7/48	2.83	.97	7.0	.77	6.1	4.55	35.0
7/11/48	3.66	1.37	8.3	1.15	7.6	6.0	27.7
8/4/48	4.44	1.80	9.4	1.58	8.8	7.2	23.4
11/3/48	2.95	1.02	7.2	.82	6.35	4.8	33.3
11/28/48	4.70	1.96	9.8	1.74	9.2	7.65	21.9
1/5/49	5.32	2.38	10.6	2.14	10.1	8.7	17.9
6/16/49	6.95	3.65	12.4	3.42	12.15	11.1	10.5
7/12/49	5.00	2.16	10.2	1.93	9.65	8.2	19.6
8/17/49	4.59	1.90	9.6	1.68	9.0	7.45	22.4
9/6/49	4.02	1.56	8.8	1.34	8.2	6.6	25.0
11/1/49	3.80	1.45	8.5	1.23	7.8	6.2	27.1

1/ Adjusted when necessary for antecedent rain and for missing data.

Table C-3..-Evaluation Series of Floods
Which Caused Appreciable Inundation
Sweetwater Creek Sample Tributary
Apalachicola River Watershed

Basic Defining Data of Flood		Present		Future			
		Average Results Corresponding to Given Precipitation		After Land Program Only		After Land Program and Channel Improvement	
Date	1/ Precipitation P	Runoff Y	Peak Stage	Average Y	Avg. Peak Stage	Avg. Peak Stage	Total Perce Reduction In Stage
	(in.)	(in.)	(ft.)	(in.)	(ft.)	(ft.)	
4/9/37	2.65	0.98	9.8	0.70	7.9	6.7	31.6
5/1/37	4.13	1.75	14.0	1.39	12.25	11.1	20.7
3/17/38	2.40	.88	9.1	.61	7.2	6.0	34.1
4/3/38	3.55	1.41	12.4	1.08	10.55	9.3	25.0
4/9/38	4.97	2.44	16.2	2.02	14.8	13.9	14.2
3/1/39	2.25	.82	8.6	.555	6.7	5.5	36.0
8/19/39	2.23	.81	8.5	.55	6.65	5.4	36.5
3/14/40	2.79	1.05	10.3	.75	8.4	7.2	30.1
7/10/40	2.95	1.12	10.7	.82	8.8	7.6	29.0
8/13/40	2.80	1.05	10.3	.75	8.4	7.2	30.1
3/17/42	2.33	.85	8.8	.585	6.9	5.7	35.2
3/22/42	3.67	1.47	12.7	1.13	10.9	9.65	24.0
12/30/42	3.37	1.32	11.9	1.00	10.05	8.8	26.0
1/19/43	2.55	.94	9.5	.655	7.6	6.4	32.6
1/27/43	2.10	.76	8.1	.51	6.2	5.05	37.6
3/13/43	1.96	.71	7.7	.46	5.8	4.7	39.0
3/22/43	4.04	1.70	13.7	1.33	12.0	10.8	21.2
3/30/44	2.83	1.06	10.4	.765	8.5	7.3	29.8
12/26/45	1.96	.70	7.7	.45	5.8	4.7	39.0
1/8/46	4.57	2.10	15.1	1.70	13.6	12.6	16.6
2/11/46	2.59	.95	9.7	.665	7.8	6.6	32.0
3/9/46	2.39	.87	9.0	.60	7.15	5.9	34.4
3/30/46	4.25	1.85	14.3	1.47	12.6	11.5	19.6
1/21/47	4.63	2.14	15.3	1.75	13.75	12.8	16.3
3/8/47	3.73	1.50	12.85	1.16	11.1	9.85	23.3
2/10/48	2.80	1.05	10.3	.75	8.4	7.2	30.1
4/2/48	2.36	.87	9.0	.60	7.15	5.9	34.4
4/8/48	2.72	1.02	10.1	.73	8.2	7.0	30.6
7/12/48	4.20	1.80	14.2	1.43	12.5	11.35	20.0
8/4/48	2.20	.80	8.4	.54	6.5	5.35	36.3
11/24/48	2.33	.85	8.8	.585	6.9	5.7	35.2
11/29/48	6.05	3.55	18.4	3.13	17.85	17.2	6.5
1/6/49	2.50	.92	9.4	.64	7.5	6.3	33.0
2/11/49	2.25	.82	8.6	.555	6.7	5.5	36.0

1/ Adjusted when necessary for antecedent rain and for missing data.

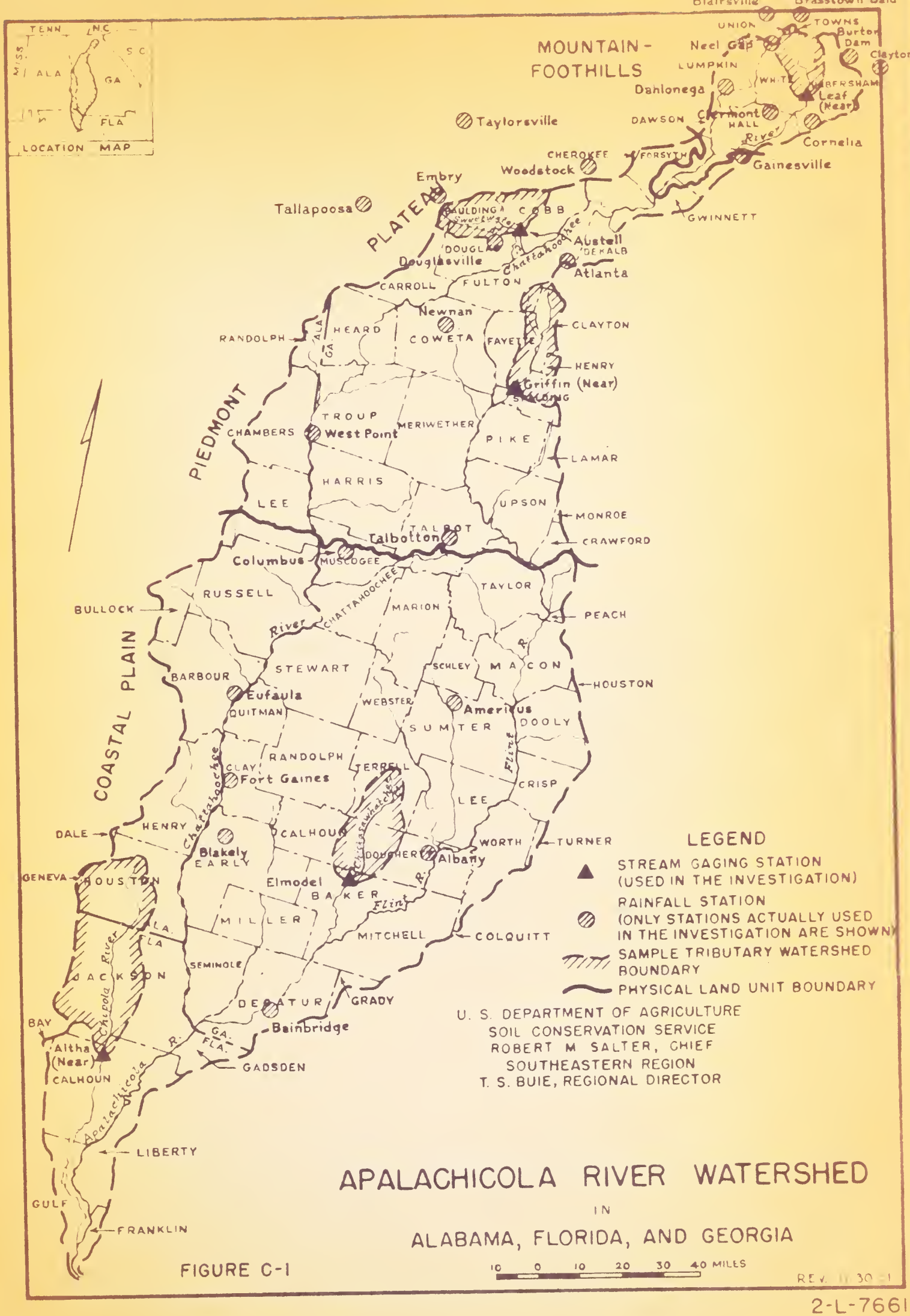


FIGURE C-1

2-L-7661-2

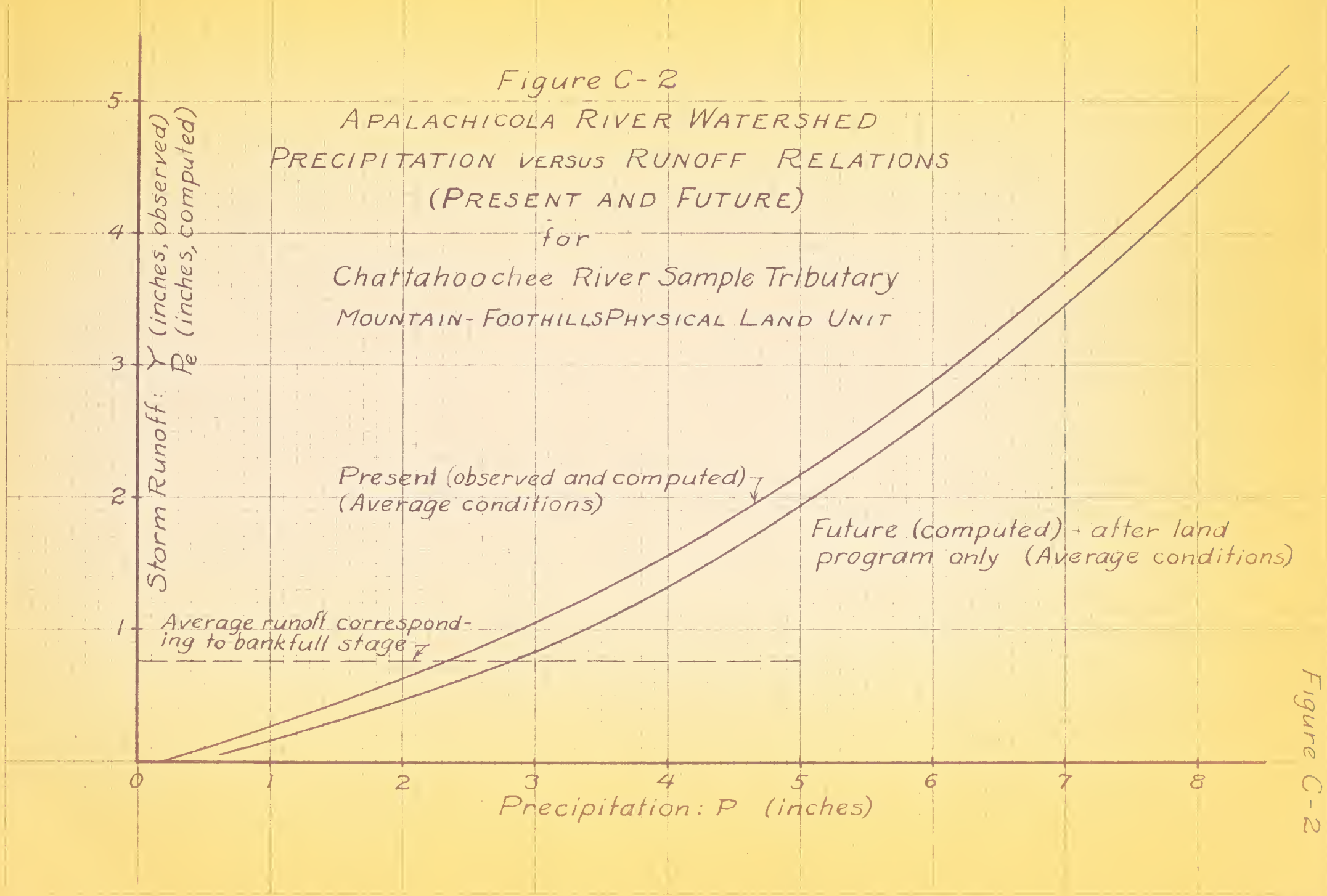


Figure C-2
APALACHICOLA RIVER WATERSHED
PRECIPITATION VERSUS RUNOFF RELATIONS
(PRESENT AND FUTURE)
for
Chattahoochee River Sample Tributary
MOUNTAIN-FOOTHILLS PHYSICAL LAND UNIT
Storm Runoff: Y (inches, observed)
Re (inches, computed)
Present (observed and computed)
(Average conditions)
Future (computed) - after land
program only (Average conditions)
Average runoff correspond-
ing to bankfull stage
0
1
2
3
4
5
6
7
8
Precipitation: P (inches)

Figure C-2

Figure C-3

APALACHICOLA RIVER WATERSHED

PRECIPITATION VERSUS RUNOFF RELATIONS

(PRESENT AND FUTURE)

for

Sweetwater Creek Sample Tributary

PIEDMONT PLATEAU PHYSICAL LAND UNIT

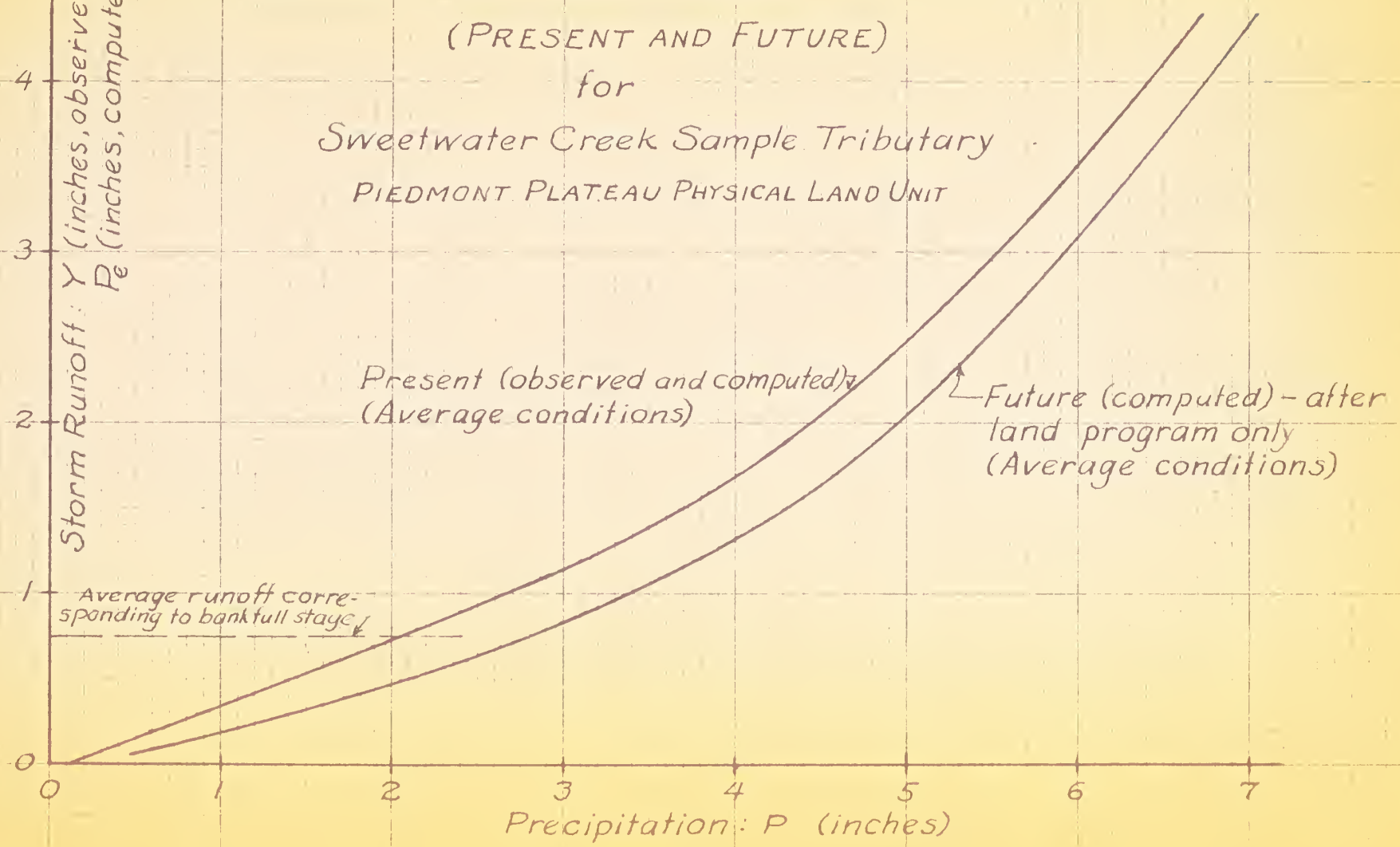


Figure C-3

Figure C-4

APALACHICOLA RIVER WATERSHED

PEAK STAGE VERSUS PRECIPITATION RELATIONS
(PRESENT AND FUTURE)
for
Chattahoochee River Sample Tributary
MOUNTAIN-FOOTHILLS PHYSICAL LAND UNIT

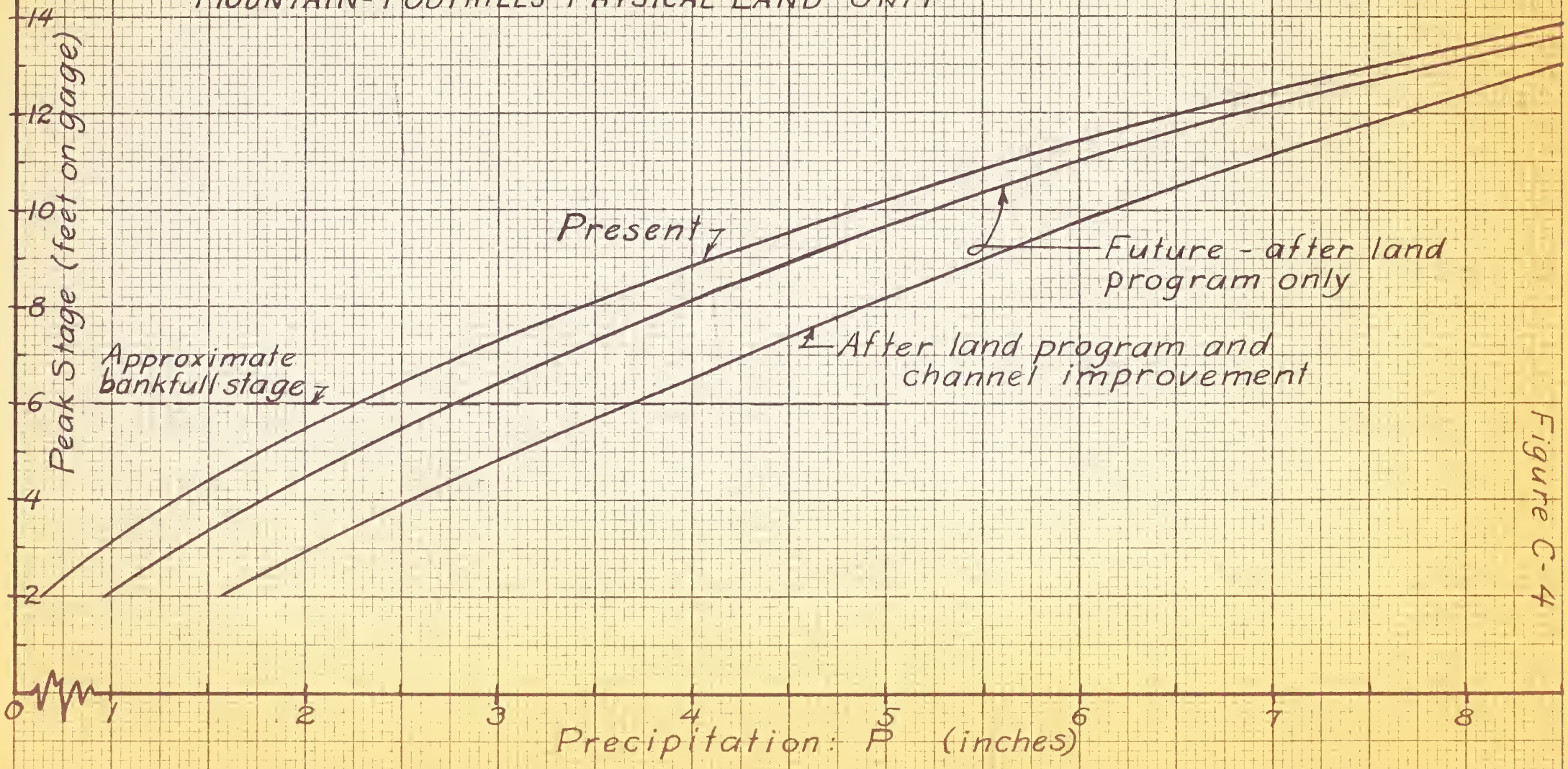


Figure C-4

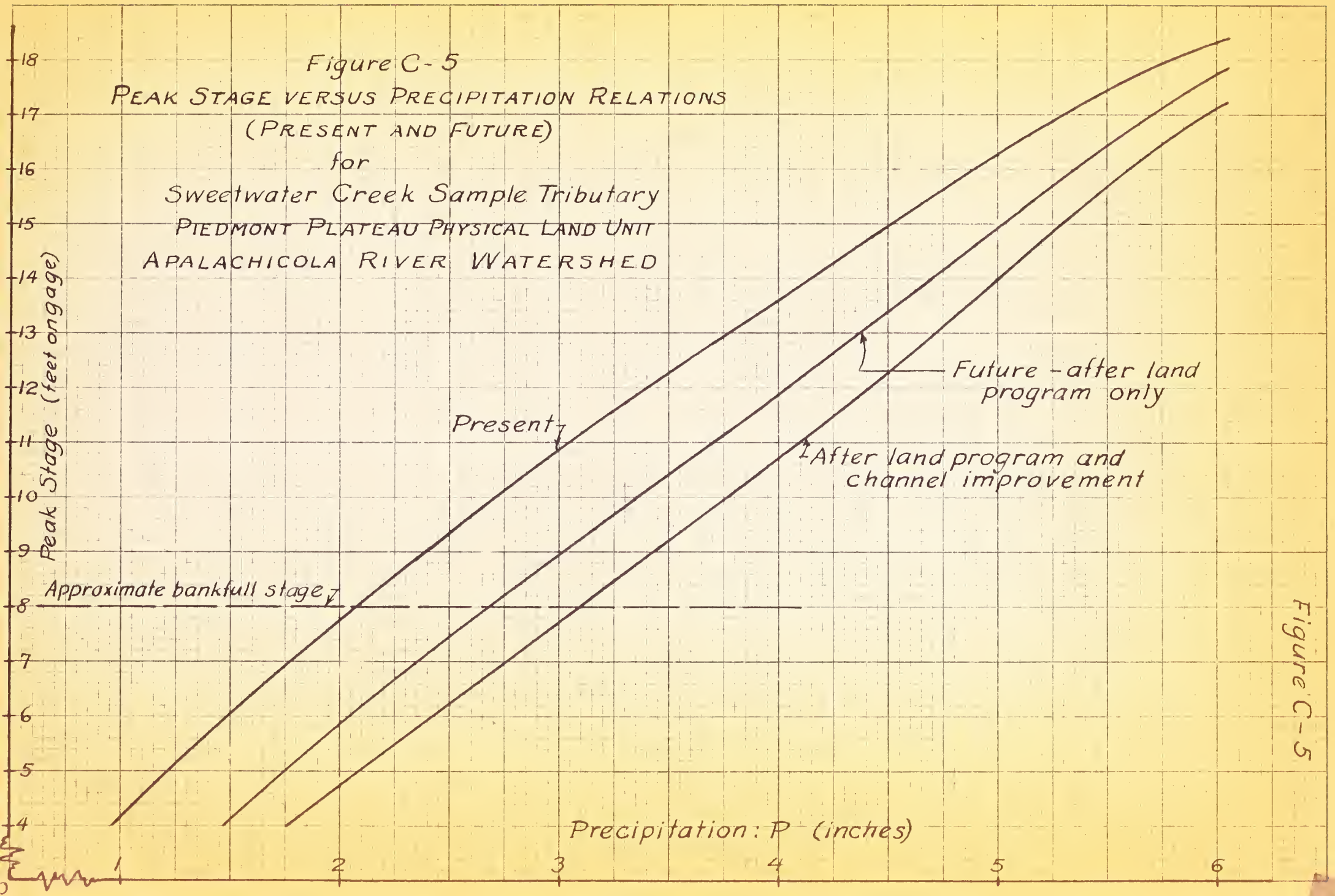
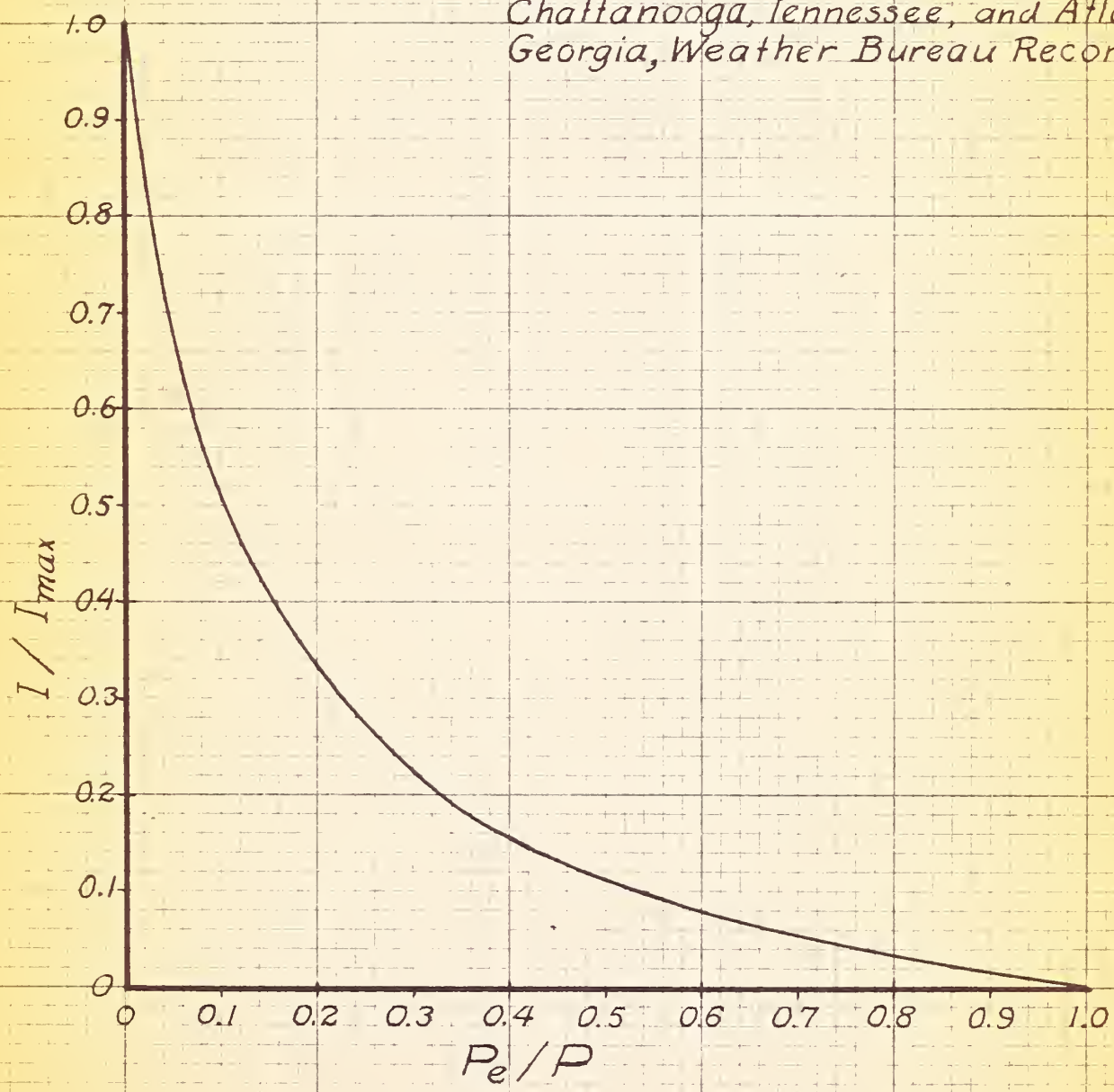


Figure C-5
PEAK STAGE VERSUS PRECIPITATION RELATIONS
(PRESENT AND FUTURE)
for
Sweetwater Creek Sample Tributary
PIEDMONT PLATEAU PHYSICAL LAND UNIT
APALACHICOLA RIVER WATERSHED
Peak Stage (feet on gage)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Approximate bankfull stage
Present
Future - after land program only
After land program and channel improvement
Precipitation: P (inches)
1
2
3
4
5
6

Figure C-5

Figure C-6
APALACHICOLA RIVER WATERSHED
DIMENSIONLESS DIAGRAM
I/I_{max} versus P_e/P Relation

(Average dimensionless diagram based on an analysis of 10-year simultaneous rainfall records from Chattanooga, Tennessee, and Atlanta, Georgia, Weather Bureau Records.)



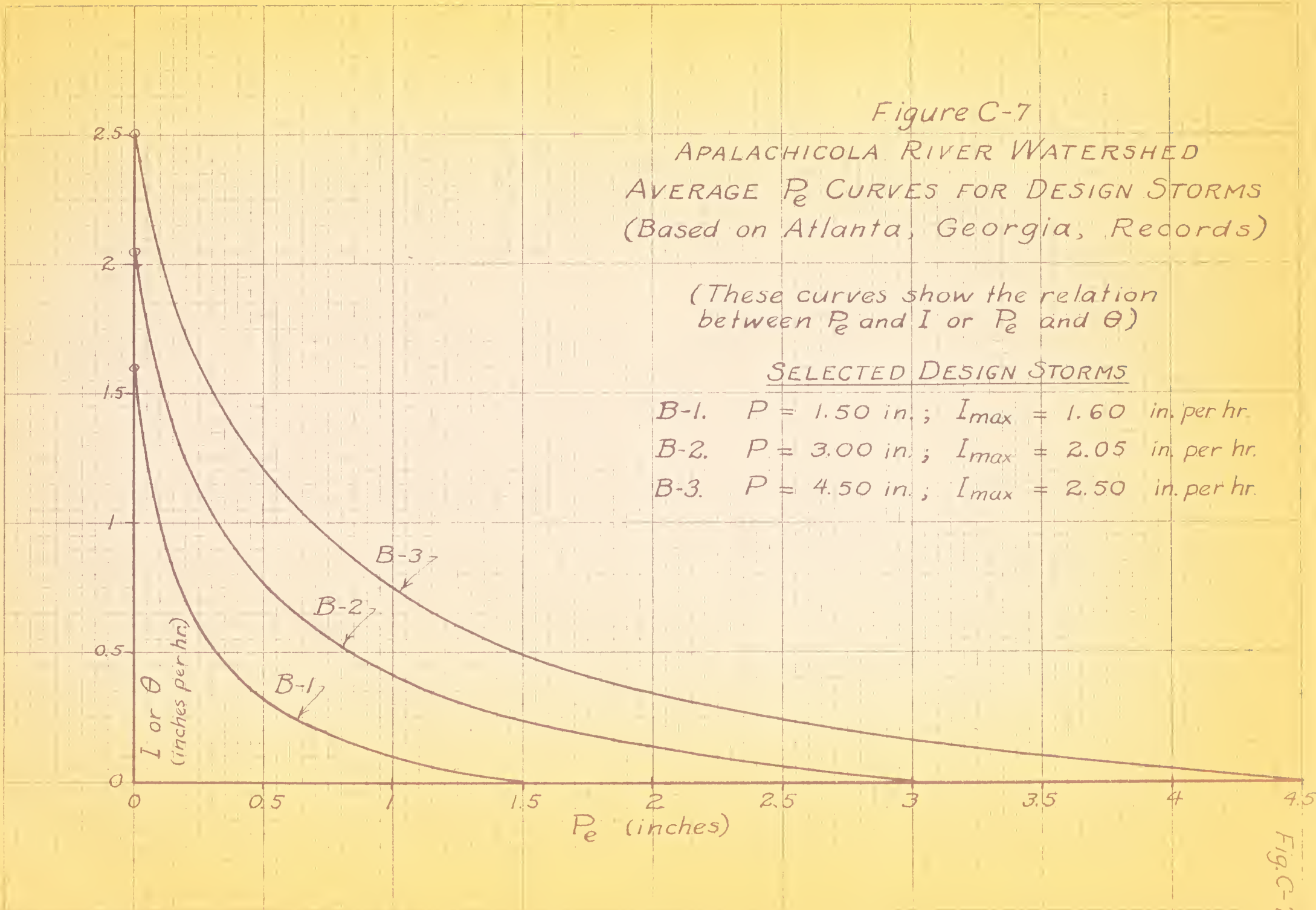


Figure C-7
APALACHICOLA RIVER WATERSHED
AVERAGE P_e CURVES FOR DESIGN STORMS
(Based on Atlanta, Georgia, Records)
(These curves show the relation between P_e and I or P_e and θ)
SELECTED DESIGN STORMS
B-1. $P = 1.50$ in.; $I_{max} = 1.60$ in. per hr.
B-2. $P = 3.00$ in.; $I_{max} = 2.05$ in. per hr.
B-3. $P = 4.50$ in.; $I_{max} = 2.50$ in. per hr.
B-3
B-2
B-1
I or θ (inches per hr.)
P_e (inches)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

Fig. C-7

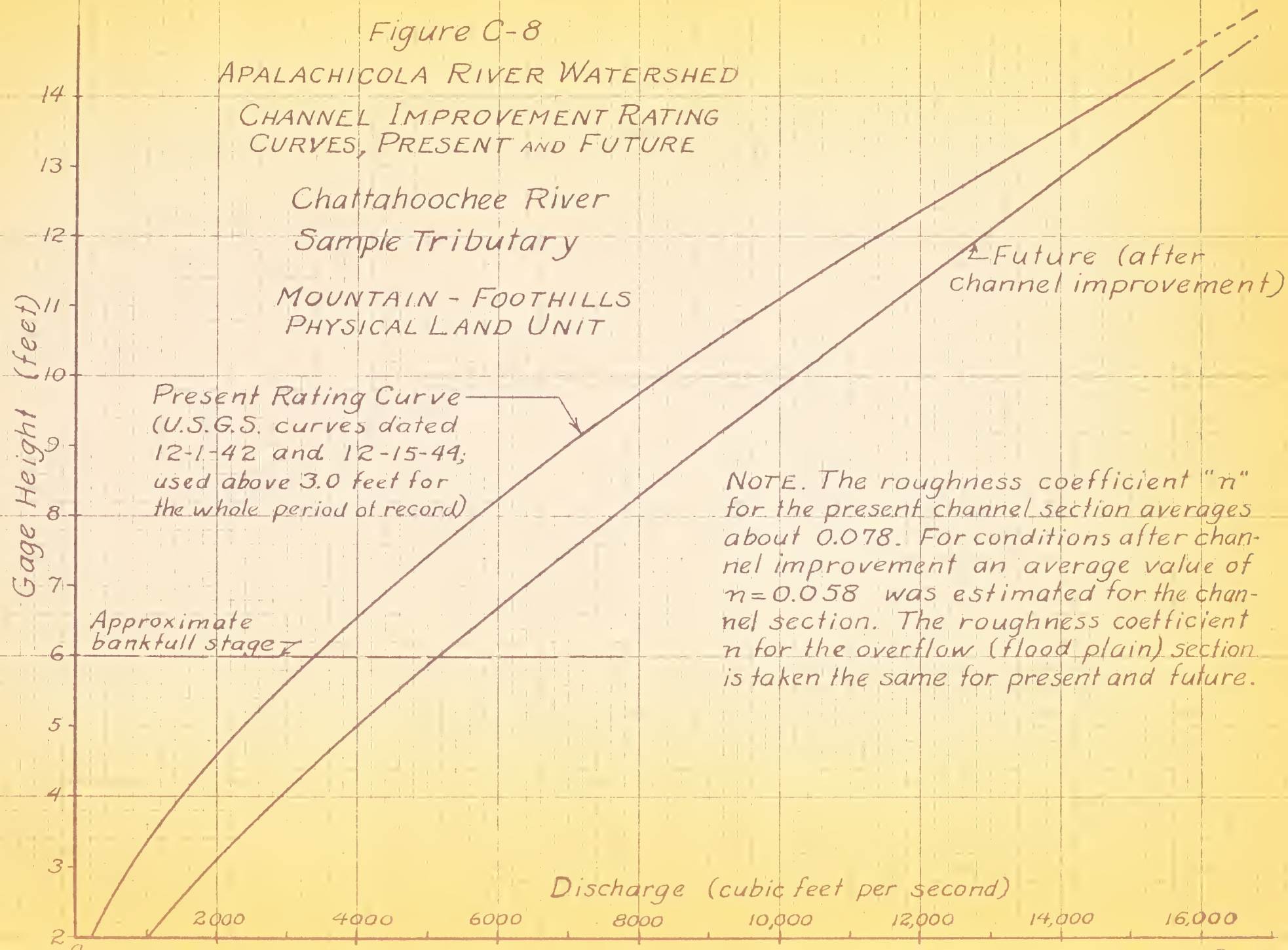


Figure C-8
APALACHICOLA RIVER WATERSHED
CHANNEL IMPROVEMENT RATING CURVES, PRESENT AND FUTURE
Chattahoochee River
Sample Tributary
MOUNTAIN - FOOTHILLS PHYSICAL LAND UNIT
Present Rating Curve (U.S.G.S. curves dated 12-1-42 and 12-15-44; used above 3.0 feet for the whole period of record)
Future (after channel improvement)
Approximate bankfull stage
NOTE. The roughness coefficient "n" for the present channel section averages about 0.078. For conditions after channel improvement an average value of n=0.058 was estimated for the channel section. The roughness coefficient n for the overflow (flood plain) section is taken the same for present and future.
Gage Height (feet)
2
3
4
5
6
7
8
9
10
11
12
13
14
Discharge (cubic feet per second)
2000
4000
6000
8000
10,000
12,000
14,000
16,000

Figure C-8

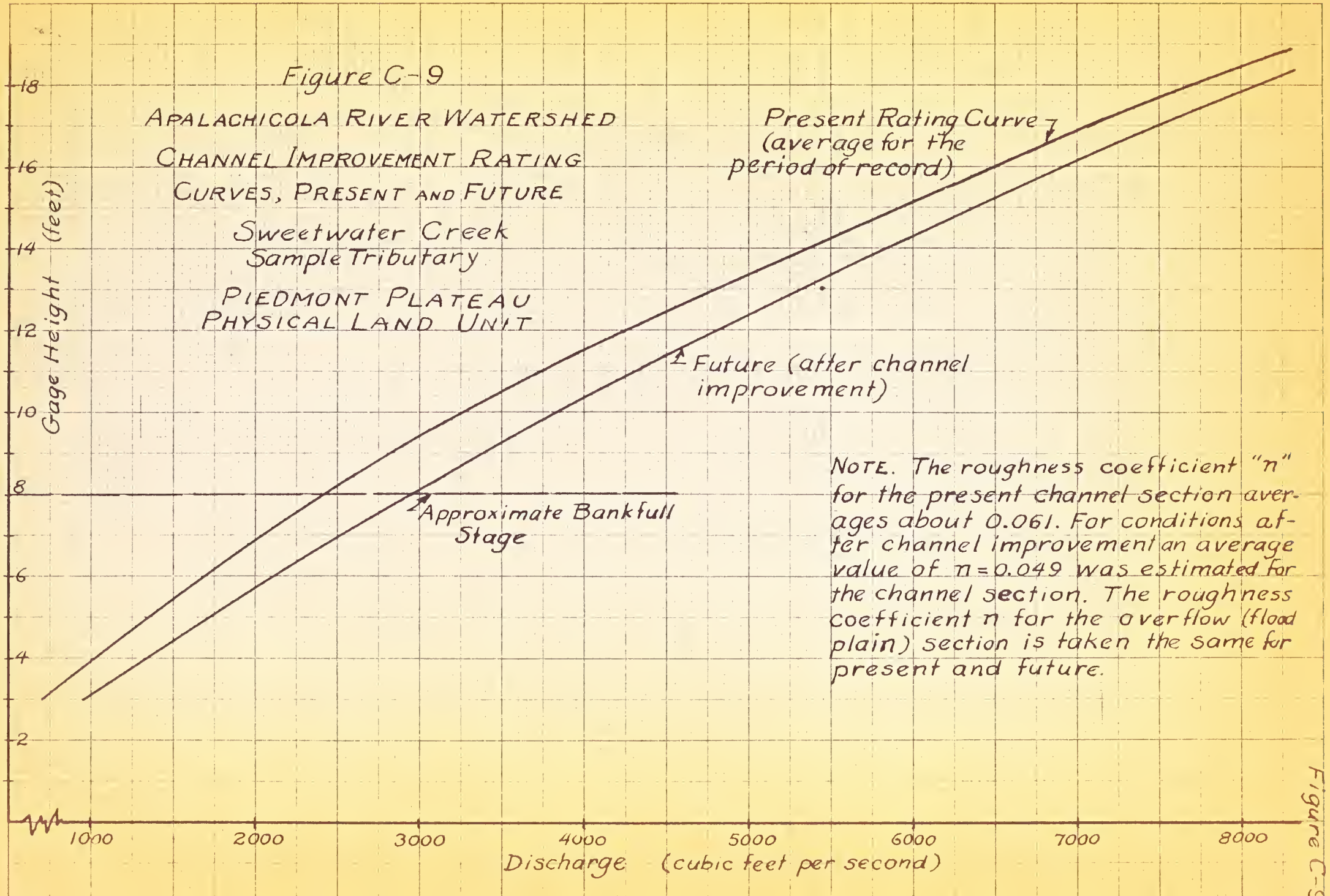
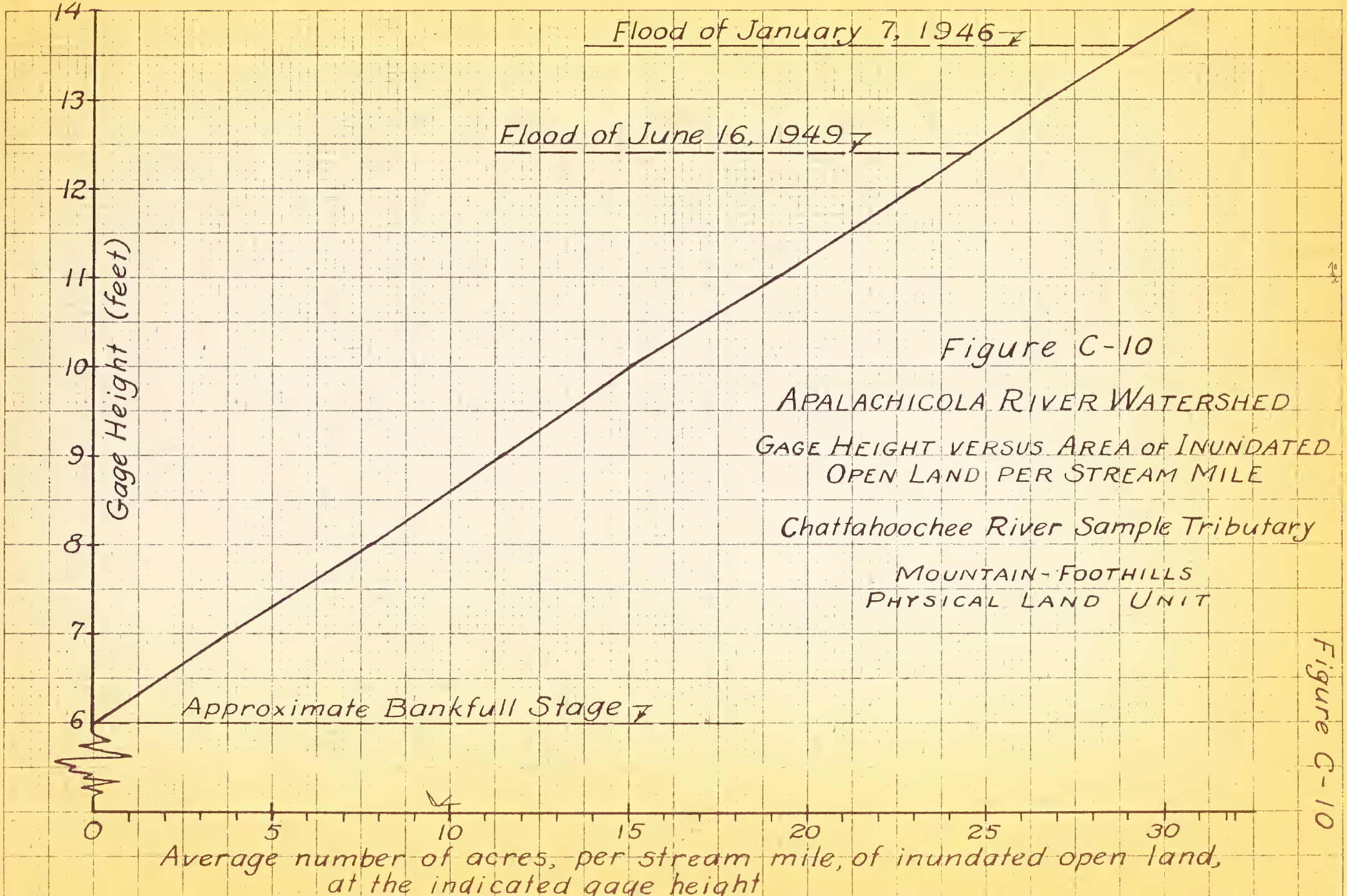


Figure C-9
APALACHICOLA RIVER WATERSHED
CHANNEL IMPROVEMENT RATING
CURVES, PRESENT AND FUTURE
Sweetwater Creek
Sample Tributary
PIEDMONT PLATEAU
PHYSICAL LAND UNIT
Present Rating Curve
(average for the
period of record)
Future (after channel
improvement)
Approximate Bankfull
Stage
NOTE. The roughness coefficient "n" for the present channel section averages about 0.061. For conditions after channel improvement an average value of n = 0.049 was estimated for the channel section. The roughness coefficient n for the overflow (flood plain) section is taken the same for present and future.
Gage Height (feet)
18
16
14
12
10
8
6
4
2
1000
2000
3000
4000
5000
6000
7000
8000
Discharge (cubic feet per second)
Figure C-9


Flood of January 7, 1946
Flood of June 16, 1949
Approximate Bankfull Stage
Gage Height (feet)
14
13
12
11
10
9
8
7
6
0
5
10
15
20
25
30
Average number of acres, per stream mile, of inundated open land, at the indicated gage height
Figure C-10
APALACHICOLA RIVER WATERSHED
GAGE HEIGHT VERSUS AREA OF INUNDATED OPEN LAND PER STREAM MILE
Chattahoochee River Sample Tributary
MOUNTAIN-FOOTHILLS PHYSICAL LAND UNIT
Figure C-10

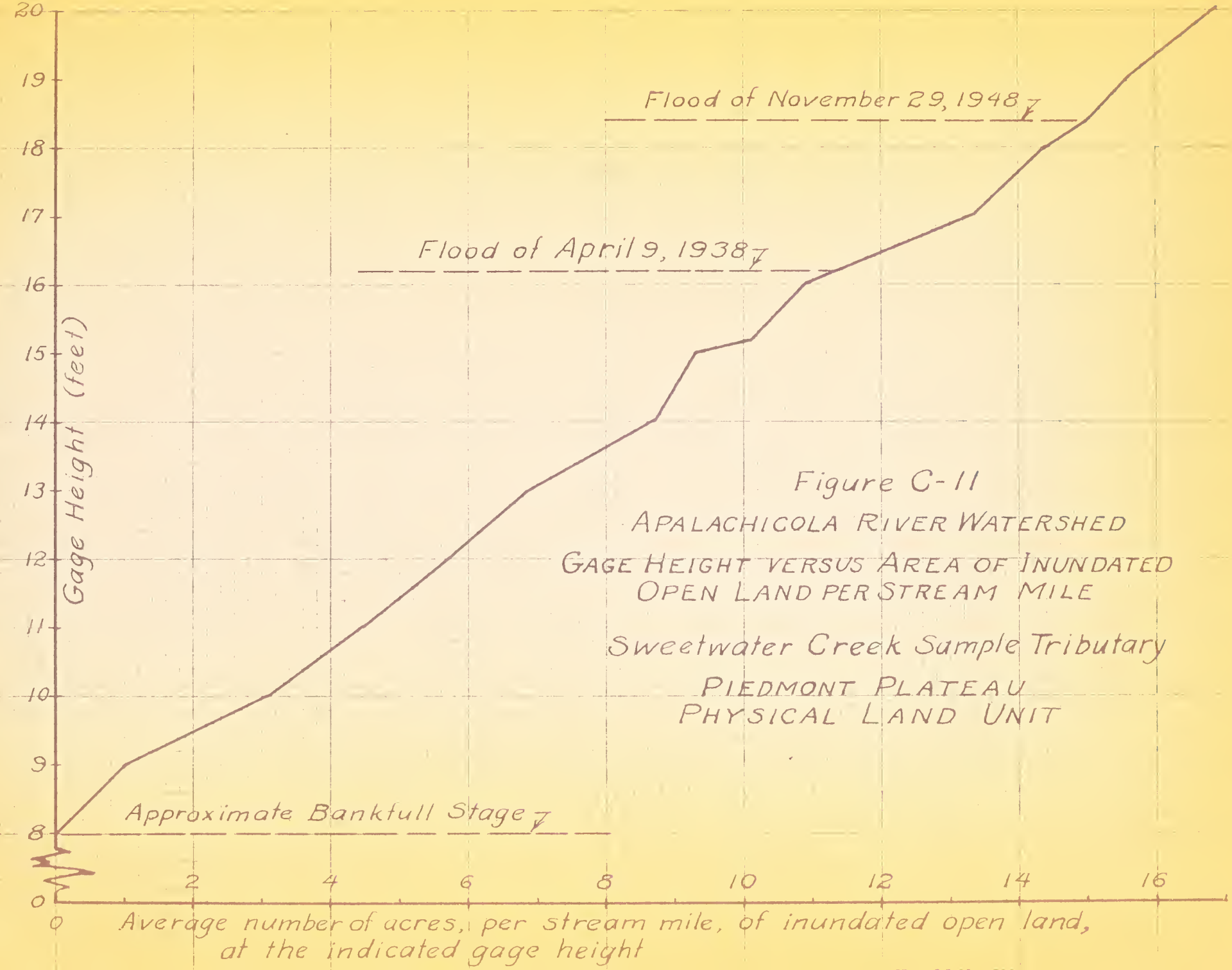


Figure C-11

APALACHICOLA RIVER WATERSHED

GAGE HEIGHT VERSUS AREA OF INUNDATED OPEN LAND PER STREAM MILE

Sweetwater Creek Sample Tributary

PIEDMONT PLATEAU PHYSICAL LAND UNIT

Figure C-11

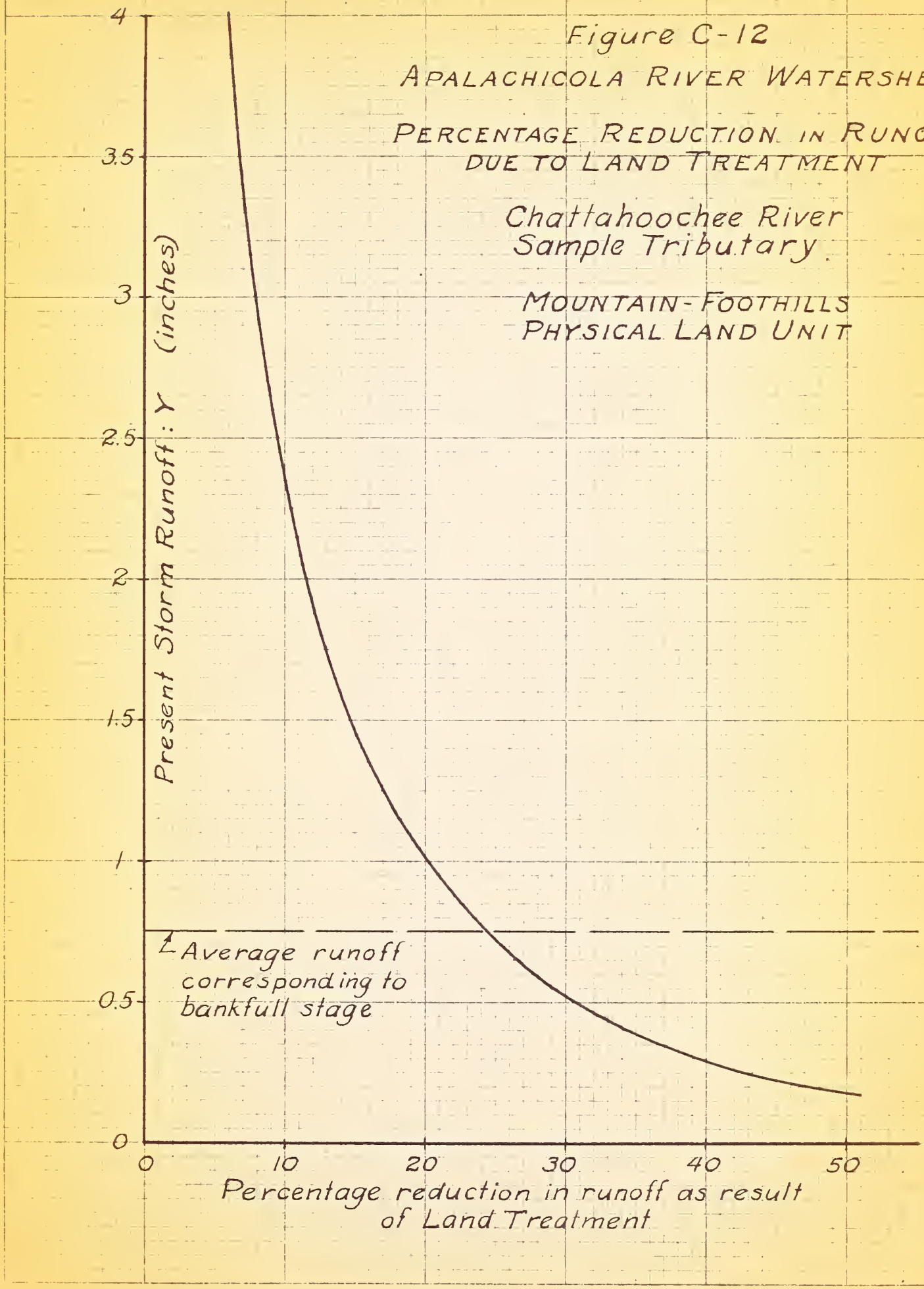


Figure C-12
APALACHICOLA RIVER WATERSHED
PERCENTAGE REDUCTION IN RUNOFF DUE TO LAND TREATMENT
Chattahoochee River Sample Tributary
MOUNTAIN-FOOTHILLS PHYSICAL LAND UNIT
Present Storm Runoff: Y (inches)
4
3.5
3
2.5
2
1.5
1
0.5
0
Average runoff corresponding to bankfull stage
0
10
20
30
40
50
Percentage reduction in runoff as result of Land Treatment

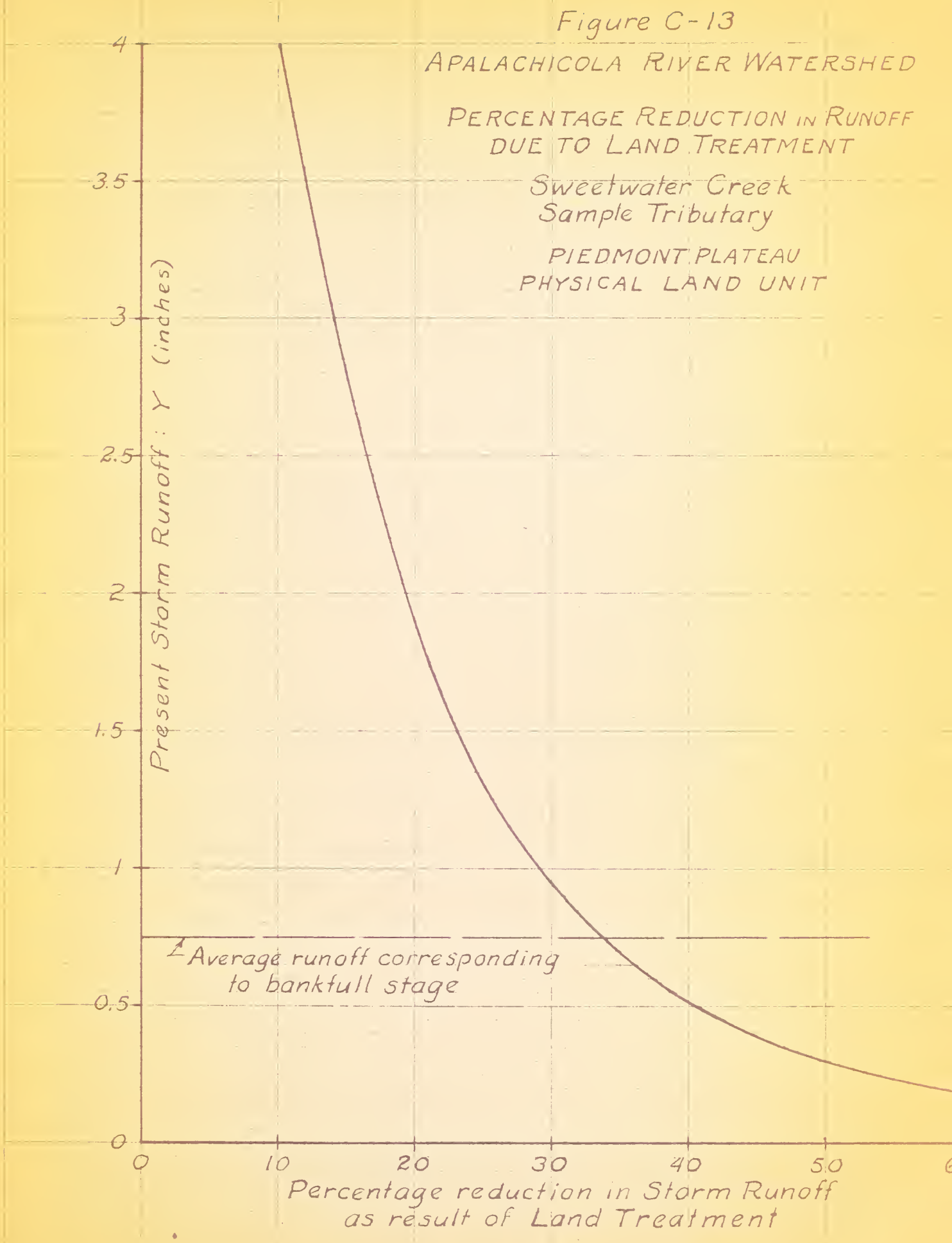


Figure C-13
APALACHICOLA RIVER WATERSHED
PERCENTAGE REDUCTION IN RUNOFF
DUE TO LAND TREATMENT
Sweetwater Creek
Sample Tributary
PIEDMONT PLATEAU
PHYSICAL LAND UNIT
Present Storm Runoff : Y (inches)
4
3.5
3
2.5
2
1.5
1
0.5
0
Average runoff corresponding
to bankfull stage
0
10
20
30
40
50
Percentage reduction in Storm Runoff
as result of Land Treatment

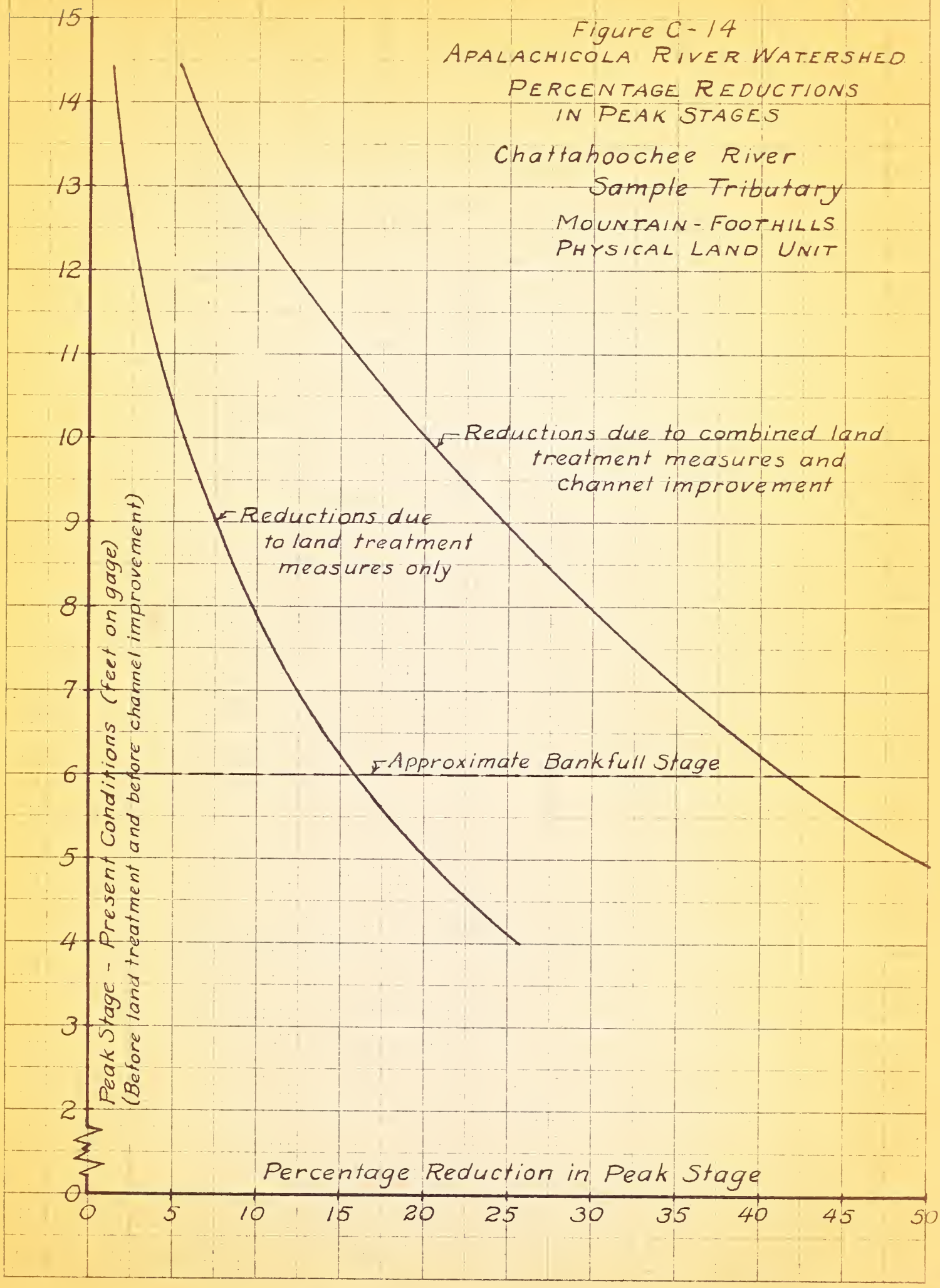


Figure C-14
APALACHICOLA RIVER WATERSHED
PERCENTAGE REDUCTIONS
IN PEAK STAGES
Chattahoochee River
Sample Tributary
MOUNTAIN-FOOTHILLS
PHYSICAL LAND UNIT
Reductions due to combined land treatment measures and channel improvement
Reductions due to land treatment measures only
Approximate Bankfull Stage
Peak Stage - Present Conditions (feet on gage)
(Before land treatment and before channel improvement)
Percentage Reduction in Peak Stage
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
5
10
15
20
25
30
35
40
45
50

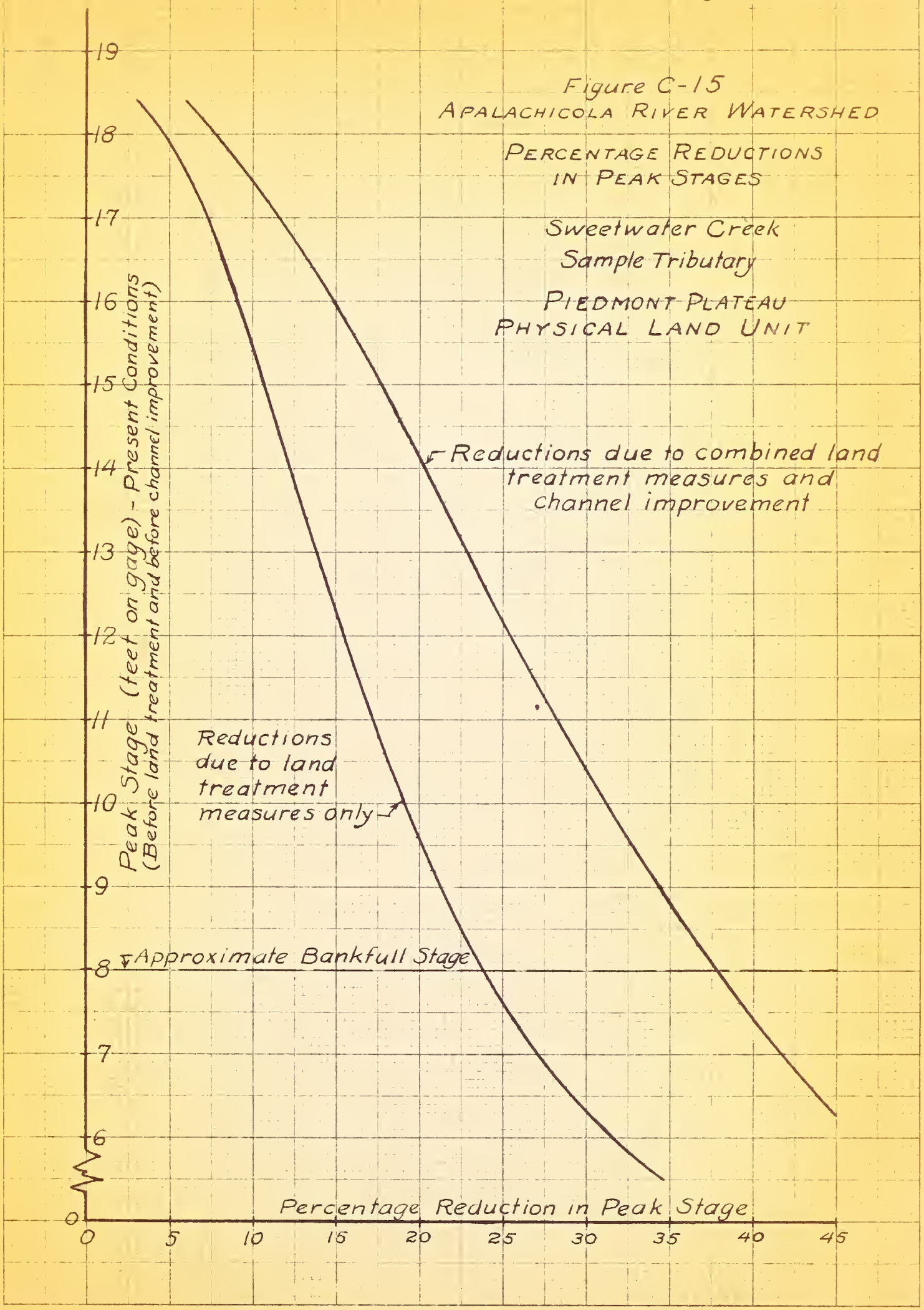


Figure C-15
APALACHICOLA RIVER WATERSHED
PERCENTAGE REDUCTIONS IN PEAK STAGES
Sweetwater Creek
Sample Tributary
PIEDMONT PLATEAU PHYSICAL LAND UNIT
Reductions due to combined land treatment measures and channel improvement
Reductions due to land treatment measures only
Approximate Bankfull Stage
Peak Stage (feet on gage) - Present Conditions
(Before land treatment and before channel improvement)
Percentage Reduction in Peak Stage
0
5
10
15
20
25
30
35
40
45
6
7
8
9
10
11
12
13
14
15
16
17
18
19

APPENDIX D

DAMAGES, BENEFITS, AND COSTS

PART I - FLOODWATER AND SEDIMENT DAMAGES

FLOODWATER DAMAGES

Introduction

Damage investigations in the Apalachicola River Watershed were conducted on sample tributary streams and on the main stems of major streams. Detailed studies were made of the following hydrologic samples: Upper Chattahoochee River for the Mountain-Foothills area, Sweetwater Creek and Upper Flint River for the Piedmont area, and Chickasawhatchee Creek and Chipola River for the Coastal Plain area. Detailed field investigations were also made of main stem reaches of the Flint and Chattahoochee Rivers and of several tributary samples other than those used primarily for hydrologic relationships. All streams in this watershed were divided into drainage area reach categories for the purpose of this study.

Damages were relatively low in the lower reaches of the larger streams (average annual damages were less than 50 cents per acre of open flood plain land). Since it was doubtful if any appreciable reductions in damages could be expected in the lower main stem reaches due to the nature of the storms producing most of the damages, no benefits were claimed.

Since floodwater damages on the Apalachicola River tributaries are largely agricultural, the investigations had to do principally with crop, pasture, fixed improvement, and land damages. Estimates were obtained from state highway departments and railroads as to the damages to public roads and railroads. All estimates are based on 1949 prices.

General Procedure and Methods

Farmers having farm land within the flood plain areas used as samples were interviewed to obtain detailed information. Information obtained included land use distribution within the flood plain, yields, fixed improvements, damageable values, and damages by depths of inundation by seasons. Further observations and contacts were made along each sample area to supplement, check, and adjust, where necessary, the information obtained from individual flood plain farmers. The experience of local agricultural field workers was sought and used as a guide in all areas in obtaining adequate local information within the watershed.

Much useful information of recent origin was obtained from the agricultural experiment stations, colleges of agriculture, and agricultural statisticians' offices in Alabama, Florida, and Georgia. This information included prices paid and received by farmers, the cost of producing crops and livestock, and practices applicable to the areas being studied.

Flooded areas were outlined on aerial photographs for one or more floods of record on each sample tributary used for this purpose, and the extent of each flood was planimetered to determine total area within the flood plain as related to the average peak flood stage. The area of open land and woodland flooded for two or more levels of flood plain was determined in this manner.

Damageable Values Per Acre

Damageable values per acre for each crop grown in the flood plain were estimated for each month of the year by physical land units. Field investigations revealed no consistent tendency for a crop, or group of crops, found growing in the open flood plain to be stratified at any given level. The average damageable value by months for all crops and pasture, therefore, was computed for a composite acre of open flood plain land in the physical land unit represented by the sample.

Examples of the two major steps involved here are shown in tables D-1 and D-2. In table D-1, the values are mid-month averages per acre for each crop grown in the flood plain. In table D-2, the values from table D-1 have been weighted by the proportionate area of open flood plain land each crop occupies to give a total damageable value for a composite acre of open flood plain land.

Seasonal Damage by Depths of Inundation

Estimates were obtained from selected farmers having considerable experience in growing crops and pasture in the flood plain, concerning the percent damage resulting from floods of different depths to various crops for each month of the year. These estimates were used as the basis for determining the percent of damage per acre by depths of inundation for each crop. Percentages in table D-3 multiplied by corn values by months in table D-2 give damages to corn by depths of inundation by months as shown in table D-4.

Damages by depth of inundation by months were computed for each crop (including pasture) grown in the flood plain. These were summarized to give flood damages to all crops and pasture per acre of open flood plain land as shown in table D-5. The same general procedure was used in computing damages to fixed improvements in this watershed.

Stage-Area by Depth of Inundation Relationships

The area of land inundated by any flood stage by one-foot intervals of inundation was determined from valley cross sections, taken at appropriate intervals, using elevations of flood lines from one or more floods of record. Planimetering of aerial photographs on which flood lines had been drawn determined total acres of flood plain, as well as acres of woodland and open land, inundated by each flood. This method of measurement separates the flood plain into two or more levels for separate determination of the major land use divisions (woodland and open land) and tends to stratify any predominantly wooded or open levels of the flood plain.

A sample summary of the acres of open flood plain land inundated by one-foot depth of inundation intervals for each foot difference in the average peak flood stage is shown in table D-6. For expansion purposes, all acreage tables were calculated on a per stream mile basis.

Stage-Damage Relationships

Tables indicating stage-damage relationships per stream mile were prepared for each sample. To obtain the crop and pasture damages per stream mile on a sample tributary for a given month and stage height, the acres of open flood plain land inundated per stream mile at various depths of inundation (by one-foot intervals) for a given stage (table D-6) were multiplied by the amount of damage per acre of open flood plain land for the corresponding depths of inundation (table D-5). The sum of these damages is the crop and pasture damage per stream mile for a flood of a given stage height. Stage-damage relationships for a Piedmont Plateau sample are shown in table D-7.

Average Annual Agricultural Damages

Average annual flood damages per stream mile were computed for each physical land unit sample by summarizing the adjusted[1/] damages per mile resulting from each flood during the period of record and dividing by the number of years in the period.

Floods during the period of record were listed chronologically, giving the date and the average peak stage of each flood (tables C-2 and C-3, Appendix C, Hydrology). The agricultural damage was obtained for each flood of record from the table showing stage-damage relationships (table D-7 is an example).

When more than one flood occurs within a given season of the year, all floods except the first are called sequent floods. Each sequent flood will do proportionately less damage to the acreage previously inundated than did any preceding flood of the season. An adjustment was made to avoid overestimation of damages.

Miles of streams on which damage reductions are expected due to the recommended program and the estimated average annual damages to agriculture by physical land units without the recommended program[2/] and with the recommended program are shown in table D-8.

Damages to Railroads and Public Roads

Estimates were obtained from state highway departments concerning annual flood damages sustained on public roads and bridges within the Apalachicola River Watershed. Similar estimates were obtained

1/ Adjusted to account for smaller proportionate damages from sequent floods.
2/ With "going" programs in effect.

from railroad officials. A summary of the estimated average annual flood damages to railroads and public roads by physical land units is shown in table D-9.

Other Damages

Evaluations of agricultural and urban damages due to inundation along the lower reaches of the two major tributaries and along the Apalachicola River are not included in this report. Large reservoirs proposed and now under construction by the Department of the Army, Corps of Engineers, will eliminate a large portion of these damages. The remaining damages in these areas are relatively small. Also, due to the location of these areas along the lower reaches of the major streams and the types of storms causing damages, it is doubtful if the recommended program would cause any significant reductions in damages due to inundation.

Occasional damage to livestock, poultry, and farm equipment was of such small consequence that no estimate was included.

Intangible and Indirect Damages

Loss of life and illness due to floods have been low in this watershed.

There are additional indirect damages such as the loss of business and wages; disruption of public utility, transportation and mail services; loss of rent; and costs of relief and sanitation. These were not evaluated monetarily due to the lack of sufficient reliable data for the purpose.

SEDIMENT AND RELATED DAMAGE

Introduction

Evaluation of sediment and related damages was made by physical land units. Three types of flood plain sedimentation damage were found. Deposition damage was caused by deposits of coarse material, largely sand, on fertile bottom lands. Swamping damage resulted when stream channels filled with sand and other erosional debris had raised the water table under adjacent flood plains. Scour damage was caused by the washing away of the flood plain surface during periods of overflow. Streambank erosion occurred occasionally but was not a significant source of economic loss.

Mountain-Foothills

In the Mountains, deposition of sand has damaged 2.9 percent of the flood plain. Scouring of the flood plain surface has damaged 1.5 percent of the first bottom area. Damage from swamping is of minor importance. Stream gradients are high, and stream channels have rock ledge or gravel bottoms. The Upper Chattahoochee River sample

tributary was used to represent this area.

In the Foothills both sheet and gully erosion are generally severe on the cleared portions of the upland. Sand deposits have damaged 3.5 percent; scour, 1.8 percent; and swamping, 12.3 percent of the flood plains in this area. The samples used to represent the Foothills were the flood plains of Hall County.

Piedmont Plateau

Both sanding and scour cause some damage in the Piedmont Plateau, but swamping is the major source of loss.

With the exception of the Chattahoochee River proper and some of the western tributaries of the Chattahoochee, channel conditions are generally poor throughout the Piedmont area. Most of the streams have been unable to transport the large amounts of sand and other erosional debris contributed from the badly eroding uplands with the result that many stream channels are almost completely filled. Channel plugs, islands, sand and mud bars are common. Frequent snags and brush also contribute to the poor condition of the channels.

Channel fill, with the accompanying rise of the water table, has made almost half of the Piedmont bottoms too wet for cultivation. About 28.6 percent of the total flood plain has been swamped to the extent that it is too wet for cultivation but is still capable of producing fair to good pasture. An additional 19.8 percent of the flood plain, formerly cultivated, is now too wet for anything but woodland.

Two sample tributary areas were used to determine sediment damages in the Piedmont Plateau. Several tributaries of the Chattahoochee River in Carroll and Heard Counties were used to represent the better drained parts of the Piedmont section. Sweetwater Creek was the sample tributary for the more typical poorly drained sections of the Piedmont.

Coastal Plain

Very little of the flood plain in the Coastal Plain area is cultivated; consequently sediment damages are of minor importance. Stream gradients are low and the flood plains are generally wide. Most of the bottom soils are inherently wet and unfit for cultivation without proper drainage. The majority of the bottom land area is in water loving hardwoods and swamp growth, although some fairly extensive areas are in pine, scrub oak, and open land.

Method of Making Flood Plain Sediment Damage Surveys

At the beginning of the survey a reconnaissance was made of the entire watershed to determine the general extent and seriousness of the sedimentation problem. Then the sample areas were selected for

detailed study. Detailed sediment damage surveys were made on sample tributaries within each physical land unit. Aerial photographs with a scale of 1 inch = 1320 feet were used as a base. The purpose of this mapping was to show the extent of physical changes in the flood plain resulting from accelerated sedimentation.

Method of Calculating Damages

The method used to calculate damages was based on determining a uniform annual increment of loss. Damage was considered as a loss of production value. The basic data used to determine amounts of sediment and related damages to flood plains were obtained from the sedimentation surveys. The following procedure was used when calculating damages:

1. The survey maps were planimetered to determine the extent, in acres, of each type and intensity class of sediment damage.

2. Values were assigned to each damage class in order to convert physical damages to monetary terms. The loss of production value resulting from the different types and degrees of damage was based on the present average annual net production value (1949 prices) per acre of open bottom lands within each physical land unit. See table below.

Average Annual Net Production Loss Resulting from Sediment Damage

Type of Damage	Damage Class	Percent Loss	Annual per Acre Loss of Production	
			Mountain-Foothills	Piedmont Plateau
			(dollars)	(dollars)
Deposition	1	20	5.20	2.20
	2	40	10.40	4.40
	3	60	15.60	6.60
Scour	1	5	1.30	0.55
	2	10	2.60	1.10
	3	15	3.90	1.65
Swamping	1	50	13.00	5.50
	2	90	23.40	9.90

3. The rate of damage (1949) was arrived at for each type of damage within the sample by multiplying net production loss for each damage class by the number of acres within that class, table D-10.

4. The only criterion of sediment damage was the condition of the flood plain at the time of the survey. The damage mapped represented the total accumulated net production loss at the time of the survey (1949). In order to calculate annual increment of loss of production value, it was first necessary to determine the number of years during which the loss had occurred. The mid-point between the beginning and peak years of agriculture development was used as the beginning of accelerated sediment damage. The number of years between this date and 1949, the year the sedimentation survey was made, represented the period of accelerated sedimentation damage. See table below.

Period of Cumulative Flood Plain Loss

	Mountain-Foothills (year)	Piedmont Plateau (year)
Beginning of Agricultural Development	1828	1823
Peak of Agricultural Development	1910	1910
Median Point (Beginning of Sediment Damage)	1869	1866
Sediment Damage Mapped	1949	1949
Years of Cumulative Loss	80	83

5. The annual increment of net production loss within the sample was determined by dividing the annual net production loss for the year of the survey (1949) by the number of years during which accelerated sedimentation damage had been taking place, table D-11.

6. The annual increment of loss of net production value was divided by the total number of acres of flood plain within each sample to determine the annual loss per acre, table D-11.

7. Damage was expanded from the sample to the entire physical land unit by multiplying the annual increment of loss per acre occurring within the sample by the total number of acres of flood plain for which the sample was considered representative, table D-12. The area of flood plain inundated by construction of the Buford Reservoir was not included in the totals for the Piedmont Plateau.

Land Damages

The average annual equivalent of loss was determined by multiplying the average annual increment of loss by 19.79277 (present value of an annuity of 1 per year at 4 percent for 40 years). It was assumed

that damage would increase at the present rate for the next 40 years and then become constant. The damage table below shows land damages with and without the recommended program. The rate of damages without the recommended program is less than present damages because of "going" programs.

Average Annual Sedimentation Damages to Land

Kind of Damage	Without Recommended Program	With Recommended Program
	(dollars)	(dollars)
Land Damage		
Deposition	15,010	6,750
Scour	1,620	1,210
Swamping	226,130	37,690
Total	242,760	45,650

In the sample calculation given below the damage figure used is $231. This figure is the average annual increment of loss from deposition occurring in the Piedmont Plateau Physical Land Unit.

Sample Calculation --

1. Average annual increment of loss without a program = $665

2. Average annual equivalent of loss without a program = $665 x 19.79277 (present value of an annuity of one year for 40 years at 4 percent) = $13,162

3. Average annual increment of loss with a program = $665 x .35 (program estimated to be 65 percent effective in reducing sediment damage) = $233

4. Average annual equivalent of loss with a program = $233 x 19.79277 (present value of an annuity of one per year for 40 years at 4 percent) = $4,612

Sedimentation of Reservoirs

There are about 140 dams in the watershed. More than 100 of these structures are small, low head developments, long since filled with sediment. About 10 small reservoirs impound water for public and industrial water supply.

The larger dams are listed in table D-13. Of the reservoirs listed, only Bartletts Ferry will be appreciably benefited by the recommended program. Most of the other dams are channel type structures built primarily for head. Ordinary stream flow is usually sufficient to meet water demand for these run-of-river developments. Sediment accumulations have little effect upon plant operation; consequently, cannot be claimed as a damage.

Two dams are now under construction by the Corps of Engineers. Buford Dam, located in the upper part of the watershed, will be benefited by the program but benefits will be small as this reservoir has an estimated useful life of more than 250 years at the present rate of sediment production. Jim Woodruff Dam, in the lower part of the watershed, is a head type structure able to operate on run-of-river.

A straight-line depreciation of investment method was used when calculating the annual loss from sedimentation. Bartletts Ferry Reservoir has a net drainage area of 3,144 square miles. The cost of the reservoir (1949 prices) was $96 per acre-foot of storage. The estimated rate of sediment production, based on a few sediment measurements in the lake, was .337 acre-feet per square mile of drainage area. This figure multiplied by the net drainage area gave an annual rate of storage loss of 1,060 acre-feet. This figure (1,060) multiplied by the cost per acre-foot of storage ($96) gave a present annual rate of loss of $101,760. This rate would be reduced to $85,478 without the recommended program, and the recommended program would cause an additional reduction to $50,880.

Silting of Public and Industrial Water Supply

There are approximately 130 water supply systems in the watershed which distribute more than 43 billion gallons of water annually. While the greatest number of systems (91) depend on ground water as a source of supply, by far the largest amount of water comes from surface sources. During 1948, 87 percent of the 43 billion gallons used came from surface sources.

The Piedmont section, which has the greatest concentration of population and industry, depends largely on surface water. Ground water supplies in this area are limited. Practically all the large centers of population and many industrial plants use treated and filtered surface water.

Most of the surface water users do not impound their supply but depend on run-of-stream. Atlanta, Georgia, the largest water user, is supplied directly from the Chattahoochee River. All of the water from surface sources is treated and filtered before use.

Existing data indicate that a high percent of the fine, suspended matter comes directly from erosion of the uplands. Except for very low turbidities, studies show a direct relationship between turbidity and the amount of chemicals needed for treatment[1/].

Damages to water supplies were calculated on the basis of the cost of chemicals needed to clarify the raw water. An estimate of $7.68 was used as the average cost of chemicals per million gallons of water treated. Of this amount, an estimated 35 percent was attributed to excessive turbidities due to high water flows.

1/ Garin, Alexis N. and Forster, G. W., Effects of Soil Erosion on the Costs of Public Water Supply, U. S. Soil Conservation Service, SCS-EC-1, July 1940.

The recommended program will reduce the cost of water treatment by reducing stream turbidities. It is anticipated that a reduction of 10 percent in the total amount of chemicals used will be accomplished when the recommended program is in effect. It is also estimated that "going programs" will account for 30 percent of the 10 percent reduction, and this amount was subtracted from the present annual damage to arrive at the annual damage "without the recommended program".

No account was taken of the expected increase in demand of future years.

The amounts of water treated and the annual damages with and without the recommended program are indicated in tables D-14 and D-15.

Sediment Damage to Drainage Enterprises

Between 1910 and 1919, drainage districts were organized in Cobb, Forsyth, Fulton, Fayette, Coweta, and Paulding Counties. These projects totaled about 13,000 acres and cost more than $350,000. Little or no provision was made for proper maintenance. In a few years there was almost complete failure because of silted channels and the drained areas were again too wet for agricultural use.

In 1938 all of the drainage districts were in poor financial condition. The total bonded debt amounted to $20.47 per acre, of which 41 percent was in default. At the present time the drainage districts are all non-operative.

The only active drainage work is on individual farms.

Benefits will result from reduced silting of drainage channels but will be small because of the limited extent of drainage work. They were not evaluated.

Sediment Damage to Navigation Channels

Several existing projects provide for improvement of the lower Apalachicola River for navigation. The Apalachicola Bay, Florida, project provides for channels from the Gulf of Mexico through Apalachicola Bay. The Gulf Intracoastal Waterway passes through about 6 miles of the lower Apalachicola River. The River and Harbor Act of March 2, 1945, approved a general plan for the full development of the Apalachicola, Chattahoochee, and Flint River system in the

combined interest of navigation and power. This plan provides for locks, dams, and dredging for navigation channels from the mouth to Columbus, Georgia, on the Chattahoochee, and from the mouth to Albany, Georgia, on the Flint.

During the fiscal year 1949, 132,777 cubic yards of sediment were dredged from the Chattahoochee River channel at a cost of $37,406 1/. 24¢ per cu yd Most of this material was attributable to soil erosion.

Effect of Sediment on Aquatic Life

Only the clear streams of the Mountain area and the lakes and springs of the Coastal Plain have any appreciable number of game fish. In the Piedmont and Foothill portions of the watershed, pollution, long periods of high turbidity, and constantly shifting channel deposits have eliminated all but the more hardy species of rough fish. Fishing conditions are generally better in the tributaries but are still greatly limited by high turbidities.

The recommended program, by reducing stream turbidities and improving channel conditions, will increase both the amount and quality of fish and other aquatic life. However, no monetary value was placed on this item.

Effect of Sediment on Incidence of Malaria

The Department of Public Health, State of Georgia, reported a very low incidence of malaria for those counties within the Apalachicola River Watershed. There has been no dredging done for the specific purpose of malaria control.

The Department of Public Health, State of Alabama, reported 3 cases of malaria in Macon County and one in Russell County during 1949. No dredging for malaria control has been done in recent years.

Improved channel conditions resulting from sediment control will do much toward keeping the incidence of malaria low.

Effect of Sediment on Recreational Values

The Apalachicola River and its tributaries are not used to any great extent for recreational purposes except in the Mountains and some parts of the Coastal Plain. High turbidities during most of the year make the river unattractive for swimming. Reduction of stream turbidities resulting from the recommended program will increase recreational attendance at public parks and other recreational areas. It is expected that concession receipts, license fees, and other recreational revenue will be increased. No benefits were claimed for these items.

1/ Annual report of Chief of Engineers, U. S. Army, 1949, U. S. Govt. Printing Office, Washington, 1950.

SUMMARY OF FLOODWATER AND SEDIMENT DAMAGES

Total average annual floodwater, sediment, and related damages, evaluated in monetary terms, are summarized by kinds without the recommended program and with the recommended program in the following table[1]:

Kind of Damage	Damages Without the Recommended Program	Damages With the Recommended Program		
		With Land Treatment Only	With Land Treatment and Channel Improvement	With All Measures Including Structures[2]
	(dollars)	(dollars)	(dollars)	(dollars)
Agricultural[3]	416,800	316,500	193,300	165,200
Railroads and Public Roads	152,300	139,100	128,800	123,300
Land:				
Deposition	15,000	8,800	8,000	6,800
Scour	1,600	1,300	1,200	1,200
Swamping	226,100	197,800	47,100	37,700
Reservoir Sedimentation	85,500	52,600	52,600	50,900
Water Treatment	92,500	72,300	72,300	72,300
Total	989,800	788,400	503,300	457,400

316 500
471 900

201400

1/ Based on 1949 prices rounded to the nearest hundred dollars.
2/ Includes land treatment, channel improvement, and floodwater retarding structures.
3/ Crop, pasture and fixed improvement damages.

PART II - COSTS AND BENEFITS OF THE RECOMMENDED PROGRAM

COSTS

All expenditures needed to install, maintain and operate the recommended remedial measures, and net increases in farm operating costs due to the recommended program are included as program costs. Unit prices used in determining these costs are shown in table D-16, sheets 1 and 2.

Increases in Normal Farm Operating Costs - Open Farm Land

Normal farm operating costs without the recommended program are shown in table D-17, while costs with the recommended program are shown in table D-18. Differences between the two sets of data give the following net increases in farm operating costs by physical land units:

	Dollars
Mountain-Foothills	386,000
Piedmont Plateau	3,996,000
Coastal Plain	22,796,000
Total Watershed	27,178,000

There are no net decreases in farm operating costs by physical land units. There will be decreases in costs for row crops due to the recommended reduction in acreage of clean tilled crops. However, corresponding recommended increases of close growing hay crops in rotation, small grain, and winter cover crops more than offset the decreases from clean tilled crops on all cropland used in rotation.

Since these increases in normal farm operating costs will not occur until increases in production have been effected, they are subject to deferral in the same manner and for the same time period used for farm income. These costs, therefore, are not expected to reach their maximum for a period of approximately 5 years after installation of the basic soil and water conservation measures. Consequently, the increase in average annual normal farm operating costs for the watershed of $27,178,000 has been discounted to $25,166,000.

Increases in Forest Land Production Costs

The net increases in forest land production costs take into consideration the temporary reductions in costs due to the deferred cut in building up stocking under the recommended program. Similarly to income, forest production costs will reach a peak when the program becomes fully effective--estimated at approximately 40 years.

Differences between average annual costs without the recommended program and average annual costs with the recommended program by physical land units show the discounted increases in forest production costs to be as follows:

	Dollars
Mountain-Foothills	366,000
Piedmont Plateau	1,088,600
Coastal Plain	4,844,800
Total Watershed	6,299,400

Cost of Installing and Maintaining Recommended Land Treatment Measures

The unit costs of individual measures were determined by applying 1949 average costs of labor, materials, and equipment to the average amounts and kinds of labor, materials, and equipment required to properly establish and maintain the measure. The number of units of each measure recommended (Appendix B, table B-2) multiplied by its unit cost determined the total cost of a specific measure. Field studies were made to determine the quantity and types of labor, materials, and equipment required for each measure.

Additional costs of educational assistance for the accelerated program were determined from information furnished by the Extension Service in Georgia, Alabama, and Florida.

Additional costs of other facilitating services were determined from information furnished by the agency responsible for the type of assistance required.

The installation and maintenance costs of specific remedial measures included in the recommended program (table D-19, sheets 1 and 2) include the costs of all facilitating services. These costs were computed separately and then combined with basic measure costs for individual measures on a prorata basis.

The total installation cost of the land treatment measures (table D-19, sheet 1) amounts to approximately $51,655,500. Of this cost the Federal Government will bear $6,415,800 (12.4 percent) for technical services; $256,500 (.5 percent) for educational assistance; $600,000 (1.2 percent) for testing and evaluation of measures; $14,506,000 (28.1 percent) for direct aids, special equipment, and materials; and $1,184,500 (2.3 percent) for administration of direct aids. Non-Federal public agencies will bear approximately $256,500 (.5 percent) for educational assistance and $1,662,100 (3.2 percent) for installation of the land treatment program on non-Federal public and private lands, including materials. Private interests will bear the remaining amount of $26,774,100 (51.8 percent).

The average annual operation and maintenance costs of the recommended land treatment measures (table D-19, sheet 2) amount to $6,070,800. The Federal Government will bear $318,700 (5.2 percent) of this cost. Non-Federal public agencies will bear $739,400 (12.2 percent), and private interests will bear $5,012,700 (82.6 percent).

It is expected that the Federal Government will bear all costs of land acquisition, as well as any costs necessary for improvement and management of lands acquired. The amount and cost of land recommended for acquisition is shown in table D-19, sheet 1, The cost of installing and maintaining adequate forest land improvement, management, and fire control measures on this land is included in table D-19, sheets 1 and 2, along with the cost of this item on other publicly- and privately-owned forest land.

Cost of Channel Improvement and Streambank Stabilization

There are approximately 6,352 miles of stream channel improvement and streambank stabilization work recommended in the watershed. The estimated installation cost for the watershed amounts to $12,515,000. The portion of this cost to be borne by the Federal Government, by non-Federal public agencies, and by private interests is shown in table D-19, sheet 1. Approximately $757,000 (6.0 percent) of this cost is for technical services, of which $749,000 is a Federal cost and $8,000 non-Federal public.

The estimated average annual operation and maintenance cost of this measure is $480,000. This cost is expected to be borne by local interests and shared between non-Federal public and private as shown in table D-19, sheet 2. It will be administered by a local agency, or agencies, acceptable to the Secretary of Agriculture.

Floodwater Retarding Structures

Field investigations indicate that approximately 1,500 floodwater retarding structures are feasible in the Apalachicola River Watershed. These are all relatively small structures with drainage areas ranging from about 500 acres to approximately 3,000 acres. It is expected that the majority of these proposed structures will be located in the Piedmont Plateau.

The estimated installation cost for the watershed amounts to $10,947,000. The portion of this cost to be borne by the Federal Government, by non-Federal public agencies, and by private interests is shown in table D-19, sheet 1. Approximately $630,000 (5.8 percent) of this cost is for technical services, of which $600,000 is a Federal cost and $30,000 is non-Federal public.

The average annual operation and maintenance cost of this measure amounts to approximately $512,000. This cost is expected to be borne by local interests and shared between non-Federal public and private as shown in table D-19, sheet 2. It will be administered by a local agency, or agencies, acceptable to the Secretary of Agriculture.

BENEFITS

Appraisal of the beneficial effects of the recommended program in the Apalachicola River Watershed includes soil and water conservation benefits accruing to farm owners and operators as a result of the open farm land treatment program, reduction in maintenance costs of railroads and public roads due to erosion control, and increased returns on public and private forest land as a result of fire control and better management.

The recommended program will also reduce flood volume and peak discharge of streams, thereby bringing about better regulation of stream flow and reduction of flood crests. The area and depth of inundation by floods of various magnitudes is reduced on most of the flood plain area. The rate of accelerated sheet and gully erosion will be greatly reduced. This will bring about benefits from reduced water turbidity and reduced sediment damages.

In the Apalachicola River Watershed, the recommended program is expected to produce measurable land enhancement benefits. Reduced damages from swamping will also produce a measurable benefit.

Prices used in determining benefits are 1949 average prices as shown in table D-20.

Flood Reduction Benefits to Agriculture

Flood reduction benefits accrue to agriculture from reduced damages to crops, pasture, and fixed improvements. Such benefits result from reductions in volumes of discharge and peak flood stages. Therefore, the difference between the damages expected before application of a measure, or group of measures, and the damages expected after application of such measures give the benefits resulting to each measure, or group of measures, applied.

Agricultural damage reduction benefits due to the recommended land treatment measures, to channel improvement, and to floodwater retarding structures are shown in table D-21.

Flood Reduction Benefits to Railroads and Public Roads

Flood reduction benefits to railroads and public roads are relatively low due to the types of storms producing damages. Benefits to railroads and public roads by physical land units and by measures are shown in table D-22.

Sediment and Related Damage Reduction Benefits

Benefits resulting from the recommended program were determined by estimating the percent reductions in flood plain losses with the remedial measures in effect. These estimates are as follows:

Estimated Reductions of Sediment Damage to Flood Plains Resulting from the Recommended Program

Type of Damage	Percent Reduction		
	Mountains	Foothills	Piedmont Plateau
Deposition of Infertile Sediment	50	65	65
Scour	30	35	35
Swamping		85	85

Sedimentation and related benefits are shown in table D-23. Benefits accruing to the "going" program have been taken out of the totals and the remaining benefits allocated to the different recommended remedial measures.

Total Floodwater, Sediment, and Land Damage Reduction Benefits Evaluated Monetarily

All damage reduction benefits evaluated monetarily are summarized for the watershed in table D-24. Of a total benefit amounting to approximately $532,400, it is estimated that $201,400 is due to the land treatment phase of the recommended program. The full amount of these land treatment benefits are not expected to be attained until approximately 5 years after costs of remedial measures are incurred. This item discounted, to take deferred value into consideration, amounts to $186,500. Total discounted benefits from floodwater reductions amount to $517,500.

Land Enhancement Benefits

In all areas of the Piedmont Plateau and in some areas of the Coastal Plain Physical Land Unit, a measurable land enhancement benefit is expected due to the recommended program. Studies made of the flood plain soils and capability classes were used to determine streams on which works of improvement might be expected to result in a favorable benefit-cost ratio. This analysis was further refined through detailed field studies to determine which streams could be expected to produce favorable benefit-cost ratios. The opinions of local farmers, as well as those of local agricultural workers, were solicited in these studies.

From these studies it was determined that little, if any, land enhancement could be expected in the Mountain-Foothills area where the streams have relatively high gradients and well developed channels, or on streams heading in the poorer soils areas of the Coastal Plain. A high percent of the flood plain soils in the Coastal streams heading in the poorer soils areas was inherently too wet or too low in fertility, or both, to lend themselves to a higher

agricultural use than at present. However, on all of the Piedmont streams and on small Coastal tributary streams heading in the better soils areas, it was found that land enhancement benefits would result.

Land enhancement in these areas will result from decreased depth and frequency of flooding and from relief from swamping. The primary and major effect will be relief from swamping damage which has already occurred[1/] Land treatment, channel improvement, and floodwater retarding structures, where feasible, will result in a higher use of flood plain lands in these areas.

The average values of land enhancement per acre were computed separately for woodland and open land. Land enhancement values were determined by the differences between present income per acre and anticipated income per acre on bottom lands with the program in effect. Allowance was made for changes in costs and damages.

Annual land enhancement benefits are shown in table D-25. Since some time is expected to elapse between installation of the remedial measures and conversion of the flood plain to a higher land use, benefits from land enhancement are deferred benefits. The estimated time required for full realization of these benefits is 5 years. Discounted land enhancement benefits due to recommended land treatment amount to $3,688,000; to stream channel improvement and streambank stabilization, $2,023,700; and to floodwater retarding structures, $442,600.

The annual equivalent of discounted land enhancement benefits to recommended land treatment measures, to channel improvement, and to floodwater retarding structures totals $6,154,300.

Decrease in the Rate of Soil Erosion

It is recognized that some benefits are expected to accrue to the recommended program from a decrease in the rate of soil erosion. However, due to the lack of adequate available data needed for this purpose, no monetary evaluation of the benefits due to this item has been made. In practice, also, there is likely to be some overlapping of benefits from this item and benefits from production increases.

Increased Production of Crops and Pasture

Estimated changes in crop and pasture yields due to the recommended program measures and to "going" programs are shown in table D-26. These changes in average yields were used as basic data in determining benefits to the recommended program, crediting "going" programs with their proportionate share in such changes on an areal basis.

1/ Benefits from estimated reduced swamping in the future is not included in this evaluation, but is included as a part of the sediment reduction benefit analysis.

Gross farm income without the recommended program is shown in table D-27. Gross farm income with the recommended program is shown in table D-28. Net increases in farm income by physical land units are as follows:

	Dollars
Mountain-Foothills	1,505,000
Piedmont Plateau	27,046,000
Coastal Plain	75,284,000
Total Watershed	103,835,000

Since these benefits are not expected to become fully effective for a period of approximately 5 years after installation of conservation measures, they were discounted. The discounted value for the watershed amounts to $96,149,000.

Increased Production of Forest Land

The favorable effects of the program in increasing income from timber products will reach a peak when the program becomes fully effective--estimated at approximately 40 years. At that time, without the recommended program, but assuming reasonable progress in fire protection and management under programs now in progress, gross annual income from timber will total about $51,566,000 annually--slightly more than the current level. With the recommended program in effect, annual income will total an estimated $112,945,000, representing an annual gross benefit of $61,379,000 1/.

Benefits from the program will be achieved mainly by decreasing the number of unproductive cull trees, increasing timber growth, improving the quality of timber products, and reducing mortality.

For the watershed as a whole, average annual growth rates are comparatively high, ranging from slightly less than 5½ percent in the Mountain-Foothills to more than 7 percent in the Piedmont. The fully stocked stands desirable for watershed protection which will be developed under the recommended program will take full advantage of this growth rate. Growth studies show that an average of slightly more than 1 percent of the gross annual increment is lost in mortality, and that more than 10 percent of the total sound volume of wood in the watershed is in cull trees. Under good management, as contemplated in recommendations, these trees will be removed to favor growth on merchantable and more valuable trees, and tree mortality will be reduced to a minimum. The following table shows estimated net annual growth per acre at present and in the future, with and without a program.

1/ Undiscounted future values.

Estimated Net Increment Per Acre, Present and Future
Apalachicola River Watershed

Physical Land Unit	Present	Future		
		Without Program	With Recommended Program	
			Private Land	Public Land
	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)
Mountain-Foothills	27.5	38.7	61.8	75.6
Piedmont Plateau	36.8	46.1	81.4	--
Coastal Plain	29.4	40.4	77.5	85.9

Under the recommended program a portion of each year's growth (40 to 60 percent of present growth) will be reserved until a good growing stock has been built up. The build-up will be accelerated by improved fire protection which will reduce mortality and decay. Under good management, worthless trees will be removed, desirable species will be planted, and proper cultural and logging practices will be observed. The table below shows present volume per acre and what can be expected with and without a program.

Estimated Cubic Foot Volumes Per Acre, Present and Future
Apalachicola River Watershed

Physical Land Unit	Present	Future		
		Without Program	With Recommended Program	
			Private Land	Public Land
	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)
Mountain-Foothills	687	859	1,237	1,511
Piedmont Plateau	614	768	1,253	--
Coastal Plain	587	734	1,291	1,432

Management aims, as reflected in these estimates, are predicated on public forests becoming more productive than private lands, inasmuch as public ownership will make it possible to forego current income long enough to build up stands to full productivity. Generally speaking, timber production (per acre) from public forests will be greater in volume and of better quality than that from private lands1/.

1/ On most of the private land, yields per acre will be very substantially increased under the recommended program. However, on some 1,297,500 acres on which certain forestry measures will not be adequately maintained without some form of public control of cutting practices, it is estimated there will be no net increase in timber growth in the future other than that achieved under the going program. On these lands it is assumed that increased growth resulting from improved fire protection will be offset by decreases due to practices which fail to keep the land reasonably productive.

Under the recommended program, it is expected that future production will be mainly of higher quality and more valuable timber. Timber from national forests and other public woodlands will have proportionately higher unit values, since it is proposed to build these lands up to full productivity as a reservoir to meet saw timber and other quality needs in times of emergency. Without the recommended program, private lands would eventually produce a much lower proportion of high quality products than at present and average unit value would decrease from 21.6 to about 17.3 cents per cubic foot. It is estimated that under the recommended program the average value of a cubic foot of wood product will be 22.9 and 26.9 cents for private and public lands, respectively.

A special problem in estimating program influence involved evaluating the deferment in income due to reserving part of the net annual growth to increase growing stock1/. The estimates indicate that in about the 13th year after the program is installed, annual income from timber products will equal or exceed the income that would be available if current protection and management practices continue. The value of the timber reserved to build up stocking during this period is a true cost and was so treated in evaluating the program.

The net increases in income due to the recommended program from forest land by physical land units and for the watershed, properly discounted, are as follows:

	Dollars
Mountain-Foothills	1,042,200
Piedmont Plateau	3,571,500
Coastal Plain	11,742,100
Total Watershed	16,355,800

1/ It is estimated that with the recommended program, growing stock can be increased on public land at an average annual rate equal to 60 percent of the present annual growth; and on private lands at rates of 40 and 50 percent for the Mountain-Foothills and Piedmont, and the Coastal Plain, respectively. Unit value of products and production costs were assumed to change in a straight-line relationship from present to estimated future levels with and without the recommended programs. The periods during which costs and benefits from change in income and production costs would accrue were determined graphically. Present worth of items of cost and benefit was computed as the present worth of simple increasing annuities, and discounted to the year of installation. These values were then converted to a 4 percent annual equivalent. An interest rate of 4 percent was used in all discount computations.

Benefits from Reductions in the Cost of Road Maintenance Due to Erosion Control Along Railroads and Public Roads

Representatives of State Highway Departments and of railroad companies in the watershed were contacted and information obtained on cost per mile of repairing damages caused by erosion to principal highways, improved or soil type roads, unimproved roads and to railroads.

A summary of the estimated benefits to railroads and public roads are as follows:

Annual Cost of Road Maintenance Due to Erosion

Physical Land Unit	Without Recommended Program	With Recommended Program	Benefits
	(dollars)	(dollars)	(dollars)
Mountain-Foothills	120,800	48,300	72,500
Piedmont Plateau	757,100	302,800	454,300
Coastal Plain	1,108,600	443,400	665,200
Total Watershed	1,986,500	794,500	1,192,000

Since these benefits are not expected to become fully effective for a period of approximately 5 years from the time remedial measure costs are expended, they are discounted, giving a discount value of $1,104,000.

Water Conservation Benefits

This item is comprised principally of benefits expected from fish production and recreational values of the permanent pools to be constructed as integral parts of the floodwater retarding structures. Benefits evaluated monetarily amount to approximately $1,218,400 at 1949 prices. Since only a short time (one or two years) is expected to elapse before these benefits become fully effective, they are not discounted.

PART III - SUMMARY AND COMPARISON OF BENEFITS AND COSTS OF THE RECOMMENDED PROGRAM

Benefits and costs were computed separately for the land treatment program, for channel improvement and streambank stabilization, and for floodwater retarding structures based on the 1949 cost-price level. For comparison purposes, all benefits and costs were brought to a common time basis through the process of discounting. Also, all benefits and costs, not originally expressed as average annual values, were converted to their average annual equivalent values for purpose of comparison. In converting installation and construction costs to annual values, a $2\frac{1}{2}$ percent interest rate was used on all public costs and a 4 percent rate on private costs.

Summary of Costs

The following summary shows total installation costs of the recommended program measures by measures, or groups of measures; by sources; annual equivalent values of installation cost; and other annual costs, such as annual operation and maintenance costs of recommended remedial measures and increased costs of normal farm operation. Discounted values of normal farm operation and forest production costs are included in this summary (1949 prices).

Land Treatment Costs:		
Installation		
Federal	$23,250,000	
Non-Federal Public	2,062,200	
Total Public	$25,312,200	
Annual Equivalent of Total Public		$632,800
Private	$26,343,300	
Annual Equivalent of Private		$1,053,700
Total Public and Private	$51,655,500	
Annual Equivalent of Public and Private		$1,686,500
Annual Operation and Maintenance		
Federal	$ 318,700	
Non-Federal Public	739,400	
Total Public	$ 1,058,100	
Private	$ 5,012,700	
Total Annual Public and Private		$6,070,800
Total Land Treatment Annual Equivalent Costs		$7,757,300

Channel Improvement and Streambank Stabilization Costs:		
Installation		
Federal	$11,639,000	
Non-Federal Public	124,000	
Total Public	$11,763,000	
Annual Equivalent of Total Public		$294,100
Private	$ 752,000	
Annual Equivalent of Private		$ 30,100
Total Public and Private	$12,515,000	
Annual Equivalent of Public and Private		$324,200
Annual Operation and Maintenance		
Non-Federal Public	$ 480,000	
Total Annual Public		$480,000
Total Channel Improvement Annual Equivalent Costs		$804,200
Floodwater Retarding Structure Costs:		
Installation		
Federal	$ 6,975,000	
Non-Federal Public	105,000	
Total Public	$ 7,080,000	
Annual Equivalent of Total Public		$177,000
Private	$ 3,867,000	
Annual Equivalent of Private		$154,700
Total Public and Private	$10,947,000	
Annual Equivalent of Public and Private		$331,700
Annual Operation and Maintenance		
Non-Federal Public	$ 78,500	
Private	433,500	
Total Annual Public and Private		$512,000
Total Floodwater Retarding Structure Annual Equivalent Cost		$843,700
Annual Increases in the Cost of Normal Farm Operation		$25,166,000
Annual Increases in the Cost of Forest Production		$ 6,299,400
Total Annual Equivalent Cost of the Recommended Program		$40,870,600

Summary of Benefits

Where any significant amount of time is expected to elapse between expenditure of funds for remedial measures and full realization of benefits from such measures, the benefits have been discounted to allow for the time lag. All evaluated monetary benefits attributable to the recommended program are summarized as follows by measures (1949 price level):

Type of Benefit	Benefits Attributable to			
	Land Treatment Measures	Channel Improvement	Flood-water Retarding Structures	All Recommended Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Damage Reduction				
Sediment and Related				
Land	32,100	151,600	10,600	194,300
Reservoirs	30,500	--	1,700	32,200
Water Supplies	18,900	--	--	18,900
Subtotal	81,500	151,600	12,300	245,400
Agriculture	92,800	123,200	28,100	244,100
Railroads & Public Roads	12,200	10,300	5,500	28,000
Total Damage Reduction Benefits	186,500	285,100	45,900	517,500
Land Enhancement	3,688,000	2,023,700	442,600	6,154,300
Water Conservation1/	--	--	1,218,400	1,218,400
Other Benefits:				
Increases in Farm Income	96,149,000	--	--	96,149,000
Increases in Forest Production	16,355,800	--	--	16,355,800
Decreases in Railroad & Public Road Maintenance	1,104,000	--	--	1,104,000
Subtotal Other Benefits	113,608,800	--	--	113,608,800
Total All Benefits	117,483,300	2,308,800	1,706,900	121,499,000

Conversion to Future Price Level

In order to convert benefits and costs from the 1949 price level used in all previous analyses to a future intermediate price level (1955-65), the following indexes provided by the Bureau of Agricultural Economics were used:

1/ Principally benefits to floodwater retarding structure permanent pools for fish and recreational values.

Name of Index	Index Number		Percent Change	Percent of 1949 Level
	1949	1955-1965		
Prices Received for all Farm Products	249	150	-40	60
Wholesale Lumber Prices	286	145	-49	51
Prices Paid for Items Used in Production	238	155	-35	65
Farm Wage Rates	428	275	-36	64
Construction Costs (ENR Index)	477	325	-32	68

Since some benefits and costs were of a mixed nature in relationship to available indexes, each benefit and cost item was treated separately, using a combined (weighted) index wherever needed to obtain the proper relationship between index and item converted.

Comparison of Benefits and Costs

The following table shows all comparisons of benefits and costs made in this report:

Comparison of Benefits and Costs of the
Recommended Program by Measures and Groups of Measures
Based on 1949 and Intermediate (1955-65) Price Levels
Apalachicola River Watershed

Measures	1949 Prices			Intermediate (1955-65) Prices 1/		
	Annual Cost	Annual Benefits	Benefit-Cost Ratio	Annual Cost	Annual Benefits	Benefit-Cost Ratio
	(dollars)	(dollars)		(dollars)	(dollars)	
Land Treatment 2/	39,222,700	117,485,300	3.00 to 1	25,357,400	69,116,600	2.73 to 1
Additional Measures:						
Channel Improvement 3/	804,200	2,308,800	2.87 to 1	546,900	1,388,700	2.54 to 1
Structures 4/	843,700	1,706,900	2.02 to 1	573,700	1,025,200	1.79 to 1
Subtotal	1,647,900	4,015,700	2.44 to 1	1,120,600	2,413,900	2.15 to 1
All Measures	40,870,600	121,499,000	2.97 to 1	26,478,000	71,530,500	2.70 to 1

1/ Prices expected to prevail under intermediate employment levels in the period 1955-65.
2/ Includes increases in costs of normal farm operation and forest production costs.
3/ Stream channel improvement and streambank stabilization.
4/ Floodwater retarding structures.

Table D-1. Average Damageable Values Per Acre by Months and by Crops
Piedmont Plateau Tributary Sample
Apalachicola River Watershed

Crop	Damageable Value of Crops by Months in Dollars											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Corn	--	--	--	2.84	10.25	26.00	37.88	38.58	38.58	28.93	9.65	--
Pasture	--	--	--	0.52	1.06	1.06	1.06	1.06	1.06	1.06	0.52	--
Pea and Cane Hay 1/	--	--	--	--	3.49	10.86	28.88	43.01	32.26	10.75	--	--
Lespedeza Hay	--	--	2.86	5.73	5.73	5.73	23.37	20.50	--	--	--	--
Small Grain	21.68	21.68	23.77	25.85	25.85	12.92	--	--	2.10	6.32	8.42	15.05
Truck and Vegetable Crops	--	--	5.45	25.43	49.07	67.27	85.18	78.35	47.00	15.67	--	--

1/ Includes other similar hays.

Table D-2. Damageable Values of a Composite Acre of Open Flood Plain Land
By Months and by Crops, Piedmont Plateau Tributary Sample
Apalachicola River Watershed

Crop	Weighted Average Damageable Values in Dollars											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Corn	--	--	--	0.88	3.18	8.06	11.74	11.96	11.96	8.97	2.99	--
Pasture	--	--	--	0.18	0.37	0.37	0.37	0.37	0.37	0.37	0.18	--
Pea and Cane Hay 1/	--	--	--	--	0.17	0.54	1.44	2.15	1.61	0.54	--	--
Lespedeza Hay	--	--	0.26	0.52	0.52	0.52	2.10	1.84	--	--	--	--
Small Grain	2.38	2.38	2.61	2.84	2.84	1.42	--	--	0.23	0.70	0.93	1.66
Truck and Vegetable Crops	--	--	0.05	0.25	0.49	0.67	0.85	0.78	0.47	0.16	--	--
Total Value of Composite Acre	2.38	2.38	2.92	4.67	7.57	11.58	16.50	17.10	14.64	10.74	4.10	1.66

1/ Includes other similar hays.

Table D-3. Estimated Percent Damage by Depths of Inundation by Months for Corn
Piedmont Plateau Tributary Sample
Apalachicola River Watershed 1/

Depth Inundation in Feet	Percent Damage by Months											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	--	--	--	50	75	20	0	0	0	0	0	--
2	--	--	--	75	90	50	20	10	10	10	10	--
3	--	--	--	100	100	90	60	50	50	50	50	--
4	--	--	--	100	100	100	90	80	80	80	80	--
5	--	--	--	100	100	100	100	100	100	100	100	--
6	--	--	--	100	100	100	100	100	100	100	100	--

1/ Similar estimates were made for each crop in the flood plain.

Table D-4. Estimated Damage Per Acre of Open Flood Plain Land
By Depths of Inundation by Months for Corn
Piedmont Plateau Tributary Sample
Apalachicola River Watershed 1/

Depth Inudation in Feet	Damage to Corn by Months in Dollars											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	--	--	--	0.44	2.38	1.61	0.00	0.00	0.00	0.00	0.00	--
2	--	--	--	0.66	2.86	4.03	2.35	1.20	1.20	0.90	0.30	--
3	--	--	--	0.88	3.18	7.25	7.04	5.98	5.98	4.48	1.50	--
4	--	--	--	0.88	3.18	8.06	10.57	9.57	9.57	7.18	2.39	--
5	--	--	--	0.88	3.18	8.06	11.74	11.96	11.96	8.97	2.99	--
6	--	--	--	0.88	3.18	8.06	11.74	11.96	11.96	8.97	2.99	--

1/ Similar estimates were made for each crop in the flood plain.

Table D-5. Flood Damages to Crops and Pasture Per Acre of Open Flood Plain Land
By Months and By Depths of Inundation
Piedmont Plateau Tributary Sample
Apalachicola River Watershed

Depth Inundation in Feet	Weighted Average Damage Per Acre of Open Flood Plain Land by Months in Dollars											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.48	0.48	0.70	1.79	4.92	4.11	2.42	3.66	1.68	0.89	0.37	0.33
2	0.71	0.71	1.04	2.93	6.37	6.78	5.77	5.54	3.57	2.19	0.78	0.50
3	1.19	1.19	1.61	4.19	7.18	10.36	11.46	11.01	8.55	6.14	2.19	0.83
4	1.43	1.43	1.88	4.58	7.29	11.39	15.14	14.62	12.16	8.86	3.18	1.00
5	1.43	1.43	1.88	4.58	7.29	11.39	16.31	17.01	14.55	10.65	3.78	1.00
6	1.43	1.43	1.88	4.58	7.29	11.39	16.31	17.01	14.55	10.65	3.78	1.00

Table D-6. Stage-Area Relationships Per Stream Mile
By One-Foot Depth of Inundation Intervals
Piedmont Plateau Tributary Sample
Apalachicola River Watershed

Peak Stage in Feet 1/	Acres Inundated by One-Foot Depth of Inundation Intervals					Total Acres Inundated
	1	2	3	4	5 and up	
8	0.0	--	--	--	--	0.0
9	1.0	--	--	--	--	1.0
10	2.1	1.0	--	--	--	3.1
11	1.4	2.1	1.0	--	--	4.5
12	1.2	1.4	2.1	1.0	--	5.7
13	1.2	1.2	1.4	2.1	1.0	6.9
14	1.8	1.2	1.2	1.4	3.1	8.7
15	.6	1.8	1.2	1.2	4.5	9.3
16	1.6	.6	1.8	1.2	5.7	10.9
17	2.4	1.6	.6	1.8	6.9	13.3
18	1.1	2.4	1.6	.6	8.7	14.4
19	1.2	1.1	2.4	1.6	9.3	15.6
20	1.3	1.2	1.1	2.4	10.9	16.9

1/ Stage at gage on Sweetwater Creek near Austell, Georgia.

Table D-7. Stage-Damage Relationships Per Stream Mile
Piedmont Plateau Tributary Sample
Apalachicola River Watershed

Peak Stage in Feet 1/	Damage to Fixed Improvements	Damage to Crops and Pasture by Months - Dollars									
		Dec. Jan. Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
	(dollars)										
8	0	0	0	0	0	0	0	0	0	0	0
9	1	0	1	2	5	4	2	4	2	1	0
10	2	2	3	7	17	15	11	13	7	4	2
11	3	3	5	13	27	30	27	28	18	12	4
12	7	5	8	20	37	48	50	50	37	26	9
13	12	7	10	26	46	63	74	74	58	42	15
14	17	9	13	32	58	79	97	100	80	57	20
15	22	10	15	37	65	92	117	119	98	70	25
16	27	12	18	44	75	108	139	144	118	85	30
17	31	14	21	51	90	126	162	168	137	99	35
18	36	16	23	58	100	143	186	192	158	114	41
19	40	18	26	65	110	161	213	218	181	131	47
20	42	20	29	71	119	176	237	244	204	148	53

1/ Stage at gage on Sweetwater Creek near Austell, Georgia.

Table D-8. Average Annual Flood Damages to Agriculture
Apalachicola River Watershed

Physical Land Unit	Stream Miles Represented	Damages Without Recommended Program	Damages With Recommended Program		
			Land Treatment	Channel Improvement	Floodwater Retarding Structures
	(miles)	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	568	215,600	182,300	96,000	96,000
Piedmont Plateau	4,745	194,000	129,100	93,300	65,200
Coastal Plain	1,039	7,200	5,100	4,000	4,000
Total Watershed	6,352	416,800	316,500	193,300	165,200

Table D-9. Average Annual Flood Damages
to Railroads and Public Roads
Apalachicola River Watershed

Physical Land Unit	Estimated Average Annual Damages			
	Without Recommended Program	With Recommended Program		
		Land Treatment	Land Treatment and Channel Improvement	All Measures Including Floodwater Retarding Structures
	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	9,200	8,400	6,400	6,400
Piedmont Plateau	59,300	51,900	47,000	41,500
Coastal Plain	83,800	78,800	75,400	75,400
Total	152,300	139,100	128,800	123,300

Table D-10. Sediment Damage to Flood Plains
by Types on Sample Tributaries
Apalachicola River Watershed

Tributary	Type of Damage	Damage Class	Acres	Damage
				(dollars)
Upper Chattahoochee - Mountains - 2,080 Acres	Deposition 1/	1	39	202.80
		2	96	998.40
		3	8	124.80
	Scour	1	91	118.30
		2	33	85.80
Hall County - Foothills - 4,350 Acres	Deposition	1	44	228.80
		2	192	1,996.80
		3	59	920.40
	Scour	1	61	79.30
		2	139	361.40
	Swamping	1	263	3,419.00
		2	272	6,364.80
Middle Chattahoochee - Piedmont - 3,729 Acres	Deposition	1	49	107.80
		2	158	695.20
		3	72	475.20
	Scour	1	19	10.45
		2	115	126.50
	Swamping	1	36	198.00
		2	78	772.20
Sweetwater Creek - Piedmont - 6,720 Acres	Deposition	1	221	486.20
		2	114	501.60
	Scour	1	78	42.90
	Swamping	1	2,540	13,970.00
		2	1,730	17,127.00

1/ Deposition of infertile sediment in each case.

Table D-11. Annual Increment of Damage to Flood Plains by Types on Sample Tributaries Apalachicola River Watershed

Area and Items	Deposition	Scour	Swamping
	(dollars)	(dollars)	(dollars)
Upper Chattahoochee - 1/ Mountains - 2,080 Acres:			
1. Cumulative Damage	1,326.00	204.10	--
2. Annual Increment of Damage	16.58	2.55	--
3. Annual Increment of Damage per Acre	0.0080	0.0012	--
Hall County - Foothills - 4,350 Acres:			
1. Cumulative Damage	3,146.00	440.70	9,783.80
2. Annual Increment of Damage	39.33	5.51	122.30
3. Annual Increment of Damage per Acre	0.0090	0.0013	0.0281
Middle Chattahoochee - Piedmont - 3,729 Acres:			
1. Cumulative Damage	1,278.20	136.95	970.20
2. Annual Increment of Damage	15.40	1.65	11.69
3. Annual Increment of Damage per Acre	0.0041	0.0004	0.0031
Sweetwater Creek - Piedmont - 6,720 Acres:			
1. Cumulative Damage	987.80	42.90	31,097.00
2. Annual Increment of Damage	11.90	0.52	374.66
3. Annual Increment of Damage per Acre	0.0018	0.0001	0.0558

1/ Area in sample in each case.

Note: Periods used for estimating cumulative damage were 80 years for Mountain-Foothills and 83 years for Piedmont.

Table D-12. Annual Increment of Damage to Flood Plains by Types on Entire Watershed Apalachicola River Watershed

Physical Land Unit	Total Area in Flood Plain	Deposition	Scour	Swamping	Total
	(acres)	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	32,700 1/	289	42	759	1,090
Piedmont Plateau	280,000	665	49	11,935	12,649
Total Watershed	312,700	954	91	12,694	13,739

1/ Area to be inundated by Buford Dam not included.

Table D-13. List of Important Reservoirs
Apalachicola River Watershed

Physical Land Unit	Reservoir Name and/or Owner	Stream	Original Storage Capacity (acre-feet)	Principal Use	Primary Purpose
Piedmont Plateau	Bartletts Ferry	Chattahoochee River	181,000	Power	Retention 1/
	Eagle-Phenix	Chattahoochee River	Small	Power	Head 2/
	Goat Rock	Chattahoochee River	24,750	Power	Head 2/
	Langdale	Chattahoochee River	3,000	Power	Head 4/
	North Highlands	Chattahoochee River	2,500	Power	Head 2/
	Morgan Falls	Chattahoochee River	15,000	Power	Head 2/
	Riverview	Flint River	Small	Power	Head 2/
Coastal Plain	Credille	Pataula Creek	1,300	Power	Retention 3/
	Flint River	Flint River	7,500	Power	Head 4/
	Warwick	Flint River	35,000	Power	Head 4/
	Reservoirs under Construction				
Mountain-Foothills	Buford	Chattahoochee River	2,077,000	Multi-purpose	Retention 1/
Coastal Plain	Jim Woodruff	Apalachicola River	385,000	Multi-purpose	Head 4/

1/ Will be benefited by recommended program.
2/ Filled to normal channel capacity.
3/ Low rate of silting.
4/ Can operate on run-of-river.

Table D-14. Amount of Water Treated
by Physical Land Units
Apalachicola River Watershed

Physical Land Unit	Amount Treated (1948)
	(mg)
Mountain-Foothills	636
Piedmont Plateau	36,966
Total Watershed	37,602

Table D-15. Estimated Annual Damage to Water Supplies by Physical Land Units Apalachicola River Watershed

Physical Land Unit	Annual Damage 1/	
	Without Recommended Program 2/	With Recommended Program
	(dollars)	(dollars)
Mountain-Foothills	1,560	1,220
Piedmont Plateau	90,920	71,050
Total Watershed	92,480	72,270

1/ 1949 prices.
2/ With "going" program in effect.

Table D-16. Approximate Average Prices Paid by Farmers in 1949, All Areas, Apalachicola River Watershed

Item		Unit	Cost
			(dollars)
Man labor		Hr.	0.42
Mule labor		Hr.	0.25
Farm tractor		Hr.	0.70
Cotton picking		Cwt.	2.20
Airplane dusting		Ac.	0.75
Ginning, bagging and ties		Bale	7.80
Custom rates:	Baling Hay	80# Bale	0.15
	Combining	Ac.	7.00
	Combine	Hr.	2.30
	Picking Peanuts	Ton	16.00
Fertilizer:	0-14-10	Ton	36.30
	2-10-4	Ton	36.00
	3-9-6	Ton	38.00
	4-12-4	Ton	41.80
	5-10-5	Ton	43.40
	6-8-4	Ton	45.30
	Cotton	Ton	42.20
	Tobacco	Ton	41.20
	Nitrate of Soda	Ton	65.40
	20% Phosphate	Ton	23.80
	Muriate of Potash	Ton	56.90
	Ammonium Sulfate	Ton	70.10
	Agricultural Limestone	Ton	5.60
	Borax	Ton	100.00
	Manure	Ton	3.00
Materials:	Fuel Oil	Gal.	0.17
	Tobacco Poison	Lb.	0.26
	Tobacco Sticks	Ea.	0.01
	Tobacco Cloth	Sq. Yd.	0.09
	Twine	Lb.	0.50
	Cotton Poison	Lb.	0.15
	Bags	Ea.	0.10
	Peanut Stack Poles	Ea.	0.045
	Garden Poison	Lb.	0.26
	Inoculant	Lb.	1.00

Table D-16. Approximate Average Prices Paid by Farmers in 1949, All Areas, Apalachicola River Watershed

Item		Unit	Cost
			(dollars)
Seed:	Cotton (treated)	Bu.	3.50
	Hybrid Corn	Bu.	10.80
	Open Pollinated Corn	Bu.	4.80
	Peanuts	Lb.	0.193
	Cowpeas	Bu.	6.20
	Soybeans	Bu.	4.70
	Sericea Lespedeza	Cwt.	28.70
	Bicolor Lespedeza	Lb.	1.25
	Korean Lespedeza	Cwt.	10.80
	Kobe Lespedeza	Cwt.	17.60
	Blue Lupine	Cwt.	6.50
	Hairy Vetch	Cwt.	23.40
	Crimson Clover	Cwt.	30.40
	Austrian Peas	Cwt.	8.50
	Italian Rye Grass	Cwt.	15.40
	Wheat	Bu.	3.30
	Oats	Bu.	1.45
	Rye	Bu.	3.45
	White Clover	Lb.	1.04
	Ladino Clover	Lb.	1.90
	Red Top	Lb.	0.73
	Orchard Grass	Cwt.	38.25
	Tall Fescue	Cwt.	55.00
	Tobacco	Oz.	1.25
	Potatoes	Cwt.	5.30
	Pimiento Peppers	Lb.	3.00
	Snap Beans	Lb.	.26
Plants:	Kudzu	1000	12.10
	Pimiento Peppers	1000	2.00
Feeds:	Cottonseed Meal	Cwt.	3.47
Pasture Rental		A.U.Mo.	2.00

Table D-17. Estimated Cost of Producing Crops and Pasture
Without the Recommended Program
Apalachicola River Watershed

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total for Watershed
	(dollars)	(dollars)	(dollars)	(dollars
Pasture and Temporary Grazing	301,000	5,232,000	10,167,000	15,700,000
Row Crops	1,670,000	26,235,000	95,378,000	123,283,000
Rotation Hay	308,000	4,798,000	11,276,000	16,382,000
Small Grain	200,000	3,170,000	10,605,000	13,975,000
Perennials 1/	302,000	7,660,000	2,699,000	10,661,000
Winter Cover Crops	193,000	3,919,000	5,057,000	9,169,000
Total	2,974,000	56,014,000	135,182,000	189,170,000

1/ Includes waterways and wildlife areas.

Table D-18. Estimated Cost of Producing Crops
With the Recommended Program
Apalachicola River Watershed

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total for Watershed
	(dollars)	(dollars)	(dollars)	(dollars)
Pasture and Temporary Grazing	307,000	5,607,000	13,836,000	19,750,000
Row Crops	1,547,000	21,811,000	77,868,000	101,226,000
Rotation Hay	427,000	9,155,000	29,110,000	38,692,000
Small Grain	438,000	5,175,000	25,843,000	31,456,000
Perennials 1/	393,000	10,353,000	4,136,000	14,882,000
Winter Cover Crops	248,000	2,909,000	7,185,000	10,342,000
Total	3,360,000	55,010,000	157,978,000	216,348,000

1/ Includes waterways and wildlife areas.

Table D-19. Installation Costs of the Recommended Program by Measures and Groups of Measures, Based on 1949 Average Prices
Apalachicola River Watershed

Item	Unit	Quantity	Installation Costs			
			Total Costs	Federal	Non-Federal	
					Public	Private
			(dollars)	(dollars)	(dollars)	(dollars)
Land Treatment:						
Subwatershed Waterways	Mile	3,420	1,430,400	829,800	7,200	593,400
Gully Stabilization and Sediment Control	Mile	18,684	5,042,500	3,766,200	25,100	1,251,200
Erosion Control Along Roads and Railroads	Mile	13,324	2,801,300	1,627,200	1,129,600	44,500
Field Diversions	Mile	19,390	3,660,800	1,368,800	18,200	2,273,800
Terraces	Mile	132,820	11,846,000	4,423,500	58,500	7,364,000
Perennial Vegetation Establishment	Acre	209,020	6,705,900	2,501,900	33,100	4,170,900
Perennial Vegetation Improvement	Acre	111,720	1,200,500	448,400	5,900	746,200
Pasture Establishment	Acre	104,920	5,945,600	2,220,000	29,500	3,696,100
Pasture Improvement	Acre	133,680	4,088,900	1,526,000	20,300	2,542,600
Wildlife Area Plantings	Acre	11,460	371,600	136,800	1,800	233,000
Farm Waterways	Acre	63,780	2,744,700	1,026,700	13,600	1,704,400
Improved Fire Protection	Acre	6,652,660	780,200	461,400	318,800	--
Tree Planting for Watershed Restoration	Acre	191,630	3,635,700	1,750,700	161,800	1,723,200
Cover Improvement on Private Forest Land	Acre	3,027,670	567,900	329,100	238,800	--
Public Acquisition	Acre	51,250	823,200	823,200	--	--
Development and Management of Lands to be Acquired	Acre	51,250	10,300	10,300	--	--
Subtotal			51,655,500	23,250,000	2,062,200	26,343,300
Additional Measures:						
Stream Channel Improvement & Streambank Stabilization	Mile	6,136	12,515,000	11,639,000	124,000	752,000
Floodwater Retarding Structures	Number	1,500	10,947,000	6,975,000	105,000	3,867,000
Subtotal			23,462,000	18,614,000	229,000	4,619,000
Total			75,117,500	41,864,000	2,291,200	30,962,300

Table D-19. Operation and Maintenance Costs of the Recommended Program by Measures and Groups of Measures, Based on 1949 Average Prices
Apalachicola River Watershed

Item	Unit	Quantity	Annual Operation and Maintenance Costs			
			Total Costs	Federal	Non-Federal	
					Public	Private
			(dollars)	(dollars)	(dollars)	(dollars)
Land Treatment:						
Subwatershed Waterways	Mile	3,420	92,900	--	--	92,900
Gully Stabilization and Sediment Control	Mile	18,684	130,200	--	--	130,200
Erosion Control Along Roads and Railroads	Mile	13,324	464,100	--	437,400	26,700
Field Diversions	Mile	19,390	193,900	--	--	193,900
Terraces	Mile	132,820	929,700	--	--	929,700
Perennial Vegetation Establishment	Acre	209,020	1,619,900	--	--	1,619,900
Perennial Vegetation Improvement	Acre	111,720	279,300	--	--	279,300
Pasture Establishment	Acre	104,920	843,600	--	--	843,600
Pasture Improvement	Acre	133,680	580,200	--	--	580,200
Wildlife Area Plantings	Acre	11,460	68,800	--	--	68,800
Farm Waterways	Acre	63,780	247,500	--	--	247,500
Improved Fire Protection	Acre	6,652,660	305,100	156,300	148,800	--
Tree Planting for Watershed Restoration	Acre	191,630	--	--	--	--
Cover Improvement on Private Forest Land	Acre	3,027,670	306,400	153,200	153,200	--
Public Acquisition	Acre	51,250	--	--	--	--
Development and Management of Lands to be Acquired	Acre	51,250	9,200	9,200	--	--
Subtotal			6,070,800	318,700	739,400	5,012,700
Additional Measures:						
Stream Channel Improvement & Streambank Stabilization	Mile	6,136	480,000	--	480,000	--
Floodwater Retarding Structures	Number	1,500	512,000	--	78,500	433,500
Subtotal			992,000		558,500	433,500
Total			7,062,800	318,700	1,297,900	5,446,200

Table D-20. Approximate Average Prices Received by Farmers in 1949, All Areas, Apalachicola River Watershed

Commodity	Unit	Price
		(dollars)
Cotton: Lint	Lb.	0.305
Seed	Ton	48.20
Corn	Bu.	1.33
Tobacco	Lb.	0.423
Small Grain: Wheat	Bu.	2.01
Oats	Bu.	0.95
Rye	Bu.	2.30
Hay: All Baled	Ton	19.00
Alfalfa, Baled	Ton	30.00
Mixed, Clover and Timothy, Baled	Ton	29.00
Lespedeza, Baled	Ton	28.00
Peanut, Baled	Ton	12.00
Soybeans and Cowpeas, Baled	Ton	29.00
Seed: Lespedeza	Cwt.	12.70
Soybeans	Bu.	3.20
Cowpeas	Bu.	4.10
Crimson Clover	Cwt.	23.00
Blue Lupine	Cwt.	6.00
Peanuts:	Lb.	0.105
Potatoes: Irish	Bu.	2.10
Sweet	Bu.	2.50
Truck Crops: Peppers, Pimiento	Ton	70.00
Cabbage	Ton	29.30
Snap Beans, All	Bu.	2.30
Cantaloupes	70# Crate	1.60
Tomatoes	Bu.	2.10
Cucumbers	Bu.	2.00
Pecans, All	Lb.	0.205
Watermelons	Melon	0.34
Apples	Bu.	2.00
Peaches	Bu.	2.90
Pasture Rental	A.U.Mo.	2.00
Veal Calves	Cwt.	19.74
Beef Cattle	Cwt.	17.08

Table D-21. Average Annual Floodwater Reduction Benefits
to Agriculture
Apalachicola River Watershed

Physical Land Unit	Benefits to Crops, Pasture, and Fixed Improvements Due To			
	Land Treatment Measures	Channel Improvement	Floodwater Retarding Structures	Total Benefits All Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	33,300	86,300	--	119,600
Piedmont Plateau	64,900	35,800	28,100	128,800
Coastal Plain	2,100	1,100	--	3,200
Total Watershed	100,300	123,200	28,100	251,600

Table D-22. Average Annual Floodwater Reduction Benefits to Railroads and Public Roads Apalachicola River Watershed

Physical Land Unit	Benefits to Railroads and Public Roads Due To			
	Land Treatment Measures	Channel Improvement	Floodwater Retarding Structures	Total Benefits All Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	800	2,000	--	2,800
Piedmont Plateau	7,400	4,900	5,500	17,800
Coastal Plain	5,000	3,400	--	8,400
Total Watershed	13,200	10,300	5,500	29,000

Table D-23. Average Annual Benefits from Reductions in Land and Sediment Damages due to the Recommended Program Apalachicola River Watershed

Kind of Damage Reductions	Land Treatment	Channel Improvement	Floodwater Retarding Structures	Total Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
Land Damage				
Deposition	6,200	800	1,200	8,200
Scour	300	100	0	400
Swamping	28,300	150,700	9,400	188,400
Reservoir Sedimentation	32,900	0	1,700	34,600
Water Treatment	20,200	0	0	20,200
Total	87,900	151,600	12,300	251,800

Table D-24. Summary of Average Annual Reductions in Floodwater, Sediment and Land Damages Evaluated Monetarily Apalachicola River Watershed

Source of Benefit	Land Treatment Measures	Channel Improvement	Floodwater Retarding Structures	Total All Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Agriculture	100,300	123,200	28,100	251,600
Railroads and Public Roads	13,200	10,300	5,500	29,000
Land	34,800	151,600	10,600	197,000
Reservoir Sedimentation	32,900	--	1,700	34,600
Water Treatment	20,200	--	--	20,200
Total	201,400	285,100	45,900	532,400

Table D-25. Annual Land Enhancement Benefits
Apalachicola River Watershed

Physical Land Unit	Area Enhanced	Land Enhancement Benefits Due To			
		Land Treatment	Channel Improvement	Floodwater Retarding Structures	Total Benefits All Measures
	(acres)	(dollars)	(dollars)	(dollars)	(dollars)
Mountain-Foothills	--	--	--	--	--
Piedmont Plateau	266,830	2,822,700	1,587,800	478,000	4,888,500
Coastal Plain	113,500	1,160,100	597,700	--	1,757,800
Total Watershed	380,330	3,982,800	2,185,500	478,000	6,646,300

Table D-26. Present and Future Average Yields
Apalachicola River Watershed

Crop or Crop Group	Unit	Mountain-Foothills			Piedmont			Coastal Plain		
		Present	Future	% Inc.	Present	Future	% Inc.	Present	Future	% Inc.
Flue Cured Tobacco	Lbs.	--	--	--	--	--	--	1,062	1,220	15
Corn	Bu.	23	32	39	16	24	50	14	21	50
Cotton	Lbs.	330	420	27	300	400	33	280	380	36
Peanuts	Lbs.	--	--	--	--	--	--	680	1,000	47
Truck and Vegetables	Dol.	120	150	25	90	120	33	75	110	47
Oats	Bu.	25	40	60	25	40	60	30	45	50
Soybean and Cowpea Hay	Tons	1.1	1.8	64	1.0	1.6	60	0.9	1.4	56
Lespedeza Hay	Tons	1.1	1.8	64	1.0	1.6	60	0.9	1.4	56
Sericea Hay	Tons	1.5	2.0	33	1.5	2.0	33	1.5	2.0	33
Kudzu Hay	Tons	1.5	2.0	33	1.5	2.0	33	1.5	2.0	33
Apples	Bu.	40	56	40	30	42	40	--	--	--
Peaches	Bu.	70	100	43	80	120	50	80	104	30
Pecans	Lbs.	--	--	--	80	120	50	100	150	50
Pasture	A.U.Mos.	2.5	5.0	100	2.3	5.0	117	3.0	6.0	100

Table D-27. Estimated Gross Farm Income from Crops and Pasture
Without the Recommended Program
Apalachicola River Watershed

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total for Watershed
	(dollars)	(dollars)	(dollars)	(dollars)
Pasture and Temporary Grazing	898,000	14,736,000	25,016,000	40,650,000
Row Crops	2,032,000	32,946,000	127,061,000	162,039,000
Rotation Hay	366,000	7,011,000	17,440,000	24,817,000
Small Grain	275,000	4,129,000	16,305,000	20,709,000
Perennials 1/	643,000	16,692,000	5,959,000	23,294,000
Total	4,214,000	75,514,000	191,781,000	271,509,000

1/ Includes waterways and wildlife areas.

Table D-28. Estimated Gross Farm Income from Crops and Pasture
With the Recommended Program
Apalachicola River Watershed

Land Use	Mountain-Foothills	Piedmont Plateau	Coastal Plain	Total for Watershed
	(dollars)	(dollars)	(dollars)	(dollars)
Pasture and Temporary Grazing	1,173,000	18,761,000	35,673,000	55,607,000
Row Crops	2,170,000	34,275,000	131,029,000	167,474,000
Rotation Hay	686,000	15,258,000	46,644,000	62,588,000
Small Grain	640,000	7,564,000	41,158,000	49,362,000
Perennials 1/	1,050,000	26,702,000	12,561,000	40,313,000
Total	5,719,000	102,560,000	267,065,000	375,344,000

1/ Includes waterways and wildlife areas.